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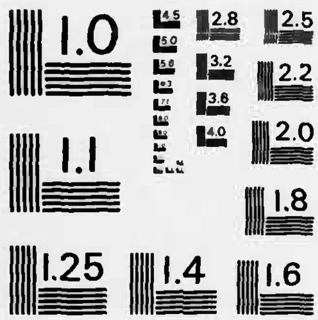

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A LIFE CYCLE COST ANALYSIS OF THE EUROPEAN VEHICLE BUY PROGRAM

THESIS

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Captain, USAF

AFIT/GLM/LSM/84S-28

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The contents of the document are technically accurate, and no sensitive items, detrimental ideas, or deleterious information are contained therein. Furthermore, the views expressed in the document are those of the author(s) and do not necessarily reflect the views of the School of Systems and Logistics, the Air University, the United States Air Force, or the Department of Defense.

AFIT/GLM/LSM/84S-28

A LIFE CYCLE COST ANALYSIS OF THE EUROPEAN VEHICLE BUY PROGRAM

THESIS

Presented to the Faculty of the School of Systems
and Logistics of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
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Abstract

The purpose of this thesis ~~research~~ was to determine if the European Vehicle Buy Program is economical. Approximately 6,000 vehicles have been purchased through the program, with 3,000 more to be bought in the near future.

A life cycle cost (LCC) model was used to determine costs. Historical costs were input into the LCC model. Extrapolation techniques were developed to project costs when historical data were not available.

This analysis supported previous studies which concluded that the European Vehicle Buy Program was economical. It concluded that the program's total cost will be $12.6 million (26%) per year less than the alternative of buying and operating American vehicles. The program can be improved to save $13.4 million (28%) per year by buying certain ground vehicle types in the United States and sending them to Europe. The additional benefit of enhanced interoperability with NATO allies also lends support to continuing the European Vehicle Buy Program. Vehicle types analyzed included buses (intercity and school) and trucks (pickup, platform, dump, tractor, panel, forklift, tank, etc.) Originator-supplied keywords include: Offshore procurement, and military vehicles.

A LIFE CYCLE COST ANALYSIS OF THE EUROPEAN VEHICLE BUY PROGRAM

I. Introduction

General Issue

Is the European Vehicle Buy Program economically justifiable? The system manager for vehicles (Warner Robins ALC/MMTV), the office of primary responsibility for all Air Force vehicle buy programs, is acutely interested in knowing whether or not the European Buy Program has proven itself justified in light of the Buy American policy. Twice since its inception, the European Buy Program has come under Congressional scrutiny, primarily over an "apples and oranges" issue concerning the comparability of data used in the preliminary analyses (21). The preliminary analyses indicated that, in terms of total life cycle cost (LCC) it would be economically advantageous in certain cases to purchase vehicles locally in Europe (21). With already 6,000 European vehicles purchased and 3,000 more to be purchased in the near future the issue merits careful study (28).

Specific Problem

Political considerations aside, it must be determined whether or not there are any differences in the total costs of purchasing, operating and maintaining, and disposing of locally manufactured European Vehicle Buy vehicles and their

American manufactured counterparts in Europe. This requires a methodology to predict the total cost of ownership for a mature current European Vehicle Buy Program and the total yearly cost of ownership of an American-made vehicle purchase program.

Background of European Vehicle Buy Program

The European Vehicle Buy Program, or European Buy Program as it is commonly called, is very similar to the normal Vehicle Priority Buy Program conducted annually to replenish the Air Force vehicle fleet. This program, however, is concerned with replenishing the Air Force vehicle fleet in Europe, and the vehicles purchased are European made.

Governmental policy towards purchasing of vehicles with federal funds essentially dictated that the vehicles be American made in accordance with the Buy American policy. Preliminary analysis, however, indicated that it would be less costly to meet certain Air Force European vehicle requirements with vehicles locally purchased in Europe. The analysis was based on a comparison of:

1) historical data, based on the already in-place American manufactured fleet, from the Air Force's Vehicle Integrated Management System (VIMS) and from the Army's vehicle management information system, and

2) historical data provided largely by the respective Offices of the Minister of Defense for the nations of the Federal Republic of Germany, the United Kingdom, and Italy based on their comparable military vehicle fleet.

Although the decision was made, as a result of the preliminary analysis, to carry out the European Buy Program, there exists an "apples and oranges" problem with the dissimilar sources of data. For instance, were maintenance costs calculated the same way by the Americans, Germans, British, and Italians?

Literature Review

This review is divided into two sections. The first half of the review accounts for how the European Buy Program was initially justified and came into existence. The second half is a short review of the LCC concept.

The European Buy Program

The Federal Republic of Germany (F.R.G.) was the site of the first vehicle buy (2, 7, 10, 17, 18, 25). The program was quickly expanded, however, into the United Kingdom (U.K.) (1, 9) and Italy (8, 19). In addition, an analysis was conducted concerning the cost effectiveness of Greek and Turkish buys (5, 20).

The Vehicle Buy Program In the Federal Republic of Germany

The Principal Deputy Assistant Secretary of Defense (Installations and Logistics), in a memorandum to his Deputy Assistant Secretary (Logistics) dated June 1, 1976, requested that the Air Force prepare an analysis, in conjunction with the Army, "of the impact on cost and logistics of purchasing general purpose, administrative use and material handling vehicles from European manufacturers, either directly or through foreign governments" (2:1). The analysis compared Air Force and Army vehicle ownership costs to those of comparable military vehicles belonging to the Federal Republic of Germany. It was reported that of the 26 vehicle types studied, 20 were expected to be more cost effective to procure from European sources (18:1).

A review was conducted of this analysis by a financial officer of the Deputy Secretary of Defense. The review primarily centered around the data used in the analysis and determined that the savings claimed in the analysis were untenable on several grounds (25:1):

1) Cost data for similar Air Force and Army vehicle types sometimes differed from one another by a factor of two. This gave rise to the suspicion that the data collection systems used by the different services did not include comparable cost elements.

2) The European vehicle cost data came from a third source with its own attendant cost elements.

3) The question arose as to whether or not American and European vehicles compared were of similar type and age.

4) The issues of special training, documentation, tools, and equipment had not been addressed.

It was recommended that a small number of vehicle types be used in a detailed validation study of the original 1976 analysis. The six types that accounted for the greatest amount of expenditures were selected. They were (25:2):

1) Compact sedans

2) Nine Passenger Carryalls

3) Five Ton Tractors

4) One/half Ton Pickup Trucks

5) Panel Trucks

6) 45 Passenger Buses

The Deputy Secretary of Defense, in a memorandum addressed jointly to the Secretary of the Air Force and the Secretary of the Army, dated April 4, 1977, ordered that a validation study be conducted (10:1). The Air Force was to assist the Office of Secretary of Defense Product Engineering Services Office (PESO) in an evaluation of their part of the original 1976 work. The anticipated cost effectiveness of the proposed program to use German vehicles was confirmed by the PESO review (17:1). Savings from ownership of the German vehicles, vice the American vehicles, was projected to be 9 percent, with a number of additional qualitative benefits being identified. Chief among these were (17:atch 1, 25:atch 1):

1) Savings during the early period of ownership resulting from increased use of the manufacturers' warranties. American manufacturers' warranties were not very effective in Europe as there was often a wasteful time delay while parts were in the transportation pipeline, and all labor was performed by Air Force vehicle maintenance personnel,
2) Improved availability of spare parts using the existing local German vehicle dealers' network,
3) Enhanced standardization and interoperability of equipment among NATO nations, and
4) A financial offset to the Federal Republic of Germany in return for their purchases of U.S. weapons.

The PESO study was also careful to point out the need for Secretary of Defense intervention to provide relief from the Buy American restrictions on (17:atch 2):

1) Specialty metals,
2) Procurement of foreign buses, and
3) Limitations on the acquisition price of station wagons and sedans (as the initial costs of these German vehicles were greater than the customary American models).

The first official sanction for the European Buy Program came to the Air Force and the Army in a letter from the Deputy Secretary of Defense dated January 30, 1978 (7:1). In

9 Passenger Carryall	12-15 Passenger Carryall
28 Passenger Bus	45 Passenger Bus
Intercity Bus	Panel Truck
Multistop Delivery Truck	1/2 Ton Pickup Truck
1 1/2 Ton Stake & Platform Truck	5 Passenger 4x2 Cargo Truck
5 Passenger 4x4 Cargo Truck	12000 Gallon Tank Truck
5 Ton Tractor	10 Ton Tractor
5 Ton 4x2 Dump Truck	5 Ton 4x4 Dump Truck
4000 lb. Electric Forklift	4000 lb. LM Forklift
4000 lb. Forklift	6000 lb. Forklift
15000 lb. Forklift	

Fig 1. Vehicles Approved Under the F.R.G. Buy Program

it the Deputy Secretary determined, for all the reasons cited above, that it would be advantageous for American forces stationed in the F.R.G. to purchase 21 specific types of German vehicles (Fig 1). The FY 78 general purpose vehicle requirements were authorized to be procured from German sources; thus marking the beginning of the European Buy Program (7:2).

The Vehicle Buy Program In the United Kingdom

A similar joint USAF/PESO study was conducted on the cost effectiveness of procuring 19 vehicle types, common to both the U.K. armed forces and the Air Force, locally in the United Kingdom. All but three of the vehicle classes examined were found to be cost effective (1:3). These 16 vehicle types (Fig 2) were subsequently approved for purchase by the Deputy Secretary of Defense to satisfy FY 79 vehicle requirements (9:2).

8-9 Passenger Carryall	12-15 Passenger Carryall
28-82 Passenger Bus	36-40 Passenger Bus
1/2 Ton Pickup Truck	Panel Truck
5-6 Passenger 4x2 Cargo Truck	Multistop Delivery Truck
Stake & Platform Truck	Dump Truck
5 Ton Tractor	10 Ton Tractor
Tank Truck	4-5000 lb. Forklift
6-7000 lb. Forklift	15-17000 lb. Forklift

Fig 2. Vehicles Approved Under the U.K. Buy Program

The Vehicle Buy Program In Italy

An Air Force study of the feasibility and cost effectiveness of using Italian non-tactical vehicles to support the Air Force mission in Italy once again had positive findings. Of the 12 vehicle types used by the Italian Minister of Defense that were comparable to Air Force/Army vehicles, eight (Fig 3) were found to be cost effective if purchased locally (19:atch 1). Approval was granted for the Italian program to commence with the FY 80 motor vehicle requirements (8:2).

9 Passenger Carryall	12-15 Passenger Carryall
22-28 Passenger Bus	1/2 Ton Pickup Truck
5-6 Passenger Cargo Truck	Multistop Delivery Truck
Panel Truck	15-16000 lb. Forklift

Fig 3. Vehicles Approved Under the Italian Buy Program

Analyses Of Cost Effectiveness Of Vehicle Buys In Greece and Turkey

As a follow-on to the German, United Kingdom, and Italian studies, the Deputy Under Secretary of Defense (Acquisition Policy) requested that the economics of buying vehicles locally in Greece and Turkey be reviewed (5:1). This time, however, it was ascertained that local purchases were infeasible due largely to a lack of local vehicle manufacturing capability (20:1).

Life Cycle Costing

The LCC concept is straightforward, but does entail an important rethinking of the word "cost". Cost must now be interpreted as being much more than just the price of an item at the time of its purchase. A product's LCC has been defined as the total cost of "acquiring the product, establishing the necessary logistics base from which to deploy and use the product and maintaining the product in operable condition over some prescribed period of time (5:29)." Absent from this definition, but commonly included in others, and of applicability to vehicles, is the cost or benefit associated with disposal of the product after its useful life is depleted (6:10, 11:58, 14:21).

Limitation of Scope

This research is concerned only with the vehicle types currently purchased under the European Buy Program. Types that were at one time purchased, but as a result of either economic or political considerations and decisions have since been deleted from the program, will not be addressed. The twenty vehicle types that are currently approved for local puchase in at least one of the three European Buy nations are listed in Fig 4. These are the vehicle types that this analysis covers.

25-29 pax School Bus	42-45 pax School Bus
41-51 pax Intercity Bus	Panel Truck
Multistop Truck	9 pax Carry-All
15 pax Carry-All	3 pax Pick-Up Truck
6 pax Pick-Up Truck	1 ton Stake & Platform Truck
1 1/2 Stake & Platform Truck	1200 gal. Gas-Oil Tank Truck
5 ton 4X2 Dump Truck	5 ton 4X4 Dump Truck
5 ton Truck Tractor	7 1/2 & 10 ton Truck Tractor
4000 lb. Forklift	6000 lb. Forklift
15000 lb. Forklift	4000 lb. Electric Forklift

Fig 4. Vehicles Currently Approved Under the European Buy Program

The issue of foreign currency exchange rates will not be addressed. Although it is recognized that fluctuating exchange rates in the F.R.G, the U.K., and Italy may impact the attractiveness of European Buy decisions. However, the complexity of predicting future exchange rates, and the longevity of some vehicles' life cycles which such a prediction must span, put it beyond the scope of this study.

Also, this analysis will not consider the question of whether purported improvements in the quality of many American vehicles will impact decisions to buy European vehicles.

Research Objectives

There are two objectives of this research. The first objective is to determine if differences exist between the annual costs of owning and operating American and European vehicles in the three nations currently involved in the European Buy Program; that is, the F.R.G., the U.K., and Italy. The second objective is to either confirm the economic benefits of the current European Buy Program or recommend modifications that would increase economic benefits.

Research Questions

Can an extrapolation be made, based on available data, concerning the likely life cycle costs differences between the American-made and European-made vehicles?

Given that such projections can be made, does the existing European Buy Program appear to be an economically attractive alternative, in terms of life cycle cost, to importing American vehicles?

What is likely to be the difference, in terms of life cycle cost, between fleets of European and American vehicles in the F.R.G., the U.K., and Italy collectively?

What modifications (i.e., cancellations), if any, appear to be advisable to maximize the economic benefits of the European Buy Program? What would be the savings?

Availability of Data

Problems pertaining to data availability for expected fleet size, acquisition cost, and salvage cost/value are relatively minor. Acquisition costs (including delivered costs) are readily available from the chief of transportation's office at HQ USAFE (HQ USAFE/LGTV) and the vehicle system manager's office (Warner Robins ALC/MMTV). Salvage cost/values are available from Bemis and Reidy's cost analysis prior to the establishment of the European Buy in the U.K. Fleet authorizations are contained in the REMS Authorizations and Assets by DODAAD listing.

Data availability for operation and maintenance costs, however, is a major problem. It would be desirable to find mean and standard deviation information on every vehicle type applicable to the European Buy Program and on the corresponding American vehicles from the same bases and organizations, but before the inception of the European Buy Program. A hypothesis test for differences in the means (after conversion to constant dollars) would indicate whether apparant differences were significant or coincidental, thus lending rigor to the study.

However, such a plan has at least three problems. First, the collection of mean and standard deviation data on all European vehicles involves a complex sampling scheme to draw representative samples (in terms of vehicle type and age) from each base in the F.R.G., the U.K., and Italy in terms of vehicle type and age. This would involve data from base-level VIMS products. These products are not available at HQ/AFLC at Wright Patterson Air Force Base or at HQ/USAFE.

It would involve the concerted cooperation of many European bases.

Second, samples arrived at in the above fashsion would generally be of very small sizes. Findings based on small samples, though supposedly representative, are not desirable.

Third, it would be necessary to insure that the comparison group was purely American-made. This entails the use of VIMS data as old as 1977. Base level data are kept for only one year. Thus, the problem becomes unworkable.

However, mean information is contained in VIMS and Command Air Force Vehicle Integrated Management System (CAFVIMS) reports. These reports are readily available and appear to be the only practical route to arrive at operation and maintenance costs.

II. Background

Life Cycle Costing

Life cycle costing is an alternative evaluation technique that is especially applicable to durable goods. LCC has proven to be a viable alternative in many Air Force purchases and may be a more economical means through which to replenish the Air Force vehicle fleet.

In 1981, the Air Force vehicle fleet was numbered at 98,274 pieces of equipment and had a combined replacement value of $2.5 billion (6:1). Even so, its replacement value may only be the tip of an even more enormous iceberg. Operation and maintenance (O&M) costs (fuel, lubricants, parts, labor, etc.) could amount to as much as 75 percent of a piece of equipment's lifelong cost of ownership (13:349). This gives rise to the concern that "unless support costs are given more than casual consideration, savings generated by low initial procurement costs may soon disappear because of abnormal life cycle support costs" (24:19).

The Air Force Logistics Command purchases vehicles for the various major commands via the General Services Administration (GSA). The GSA buys vehices for all federal activities in large competitive buys based largely on lowest initial cost. The vehicle acquisition prices paid are considered by GSA personnel to be excellent and at "rock bottom" level (14:46). In recent years, however, policy has been to buy vehicles using an abridged version of LCC that accounts for both acquisition cost and the expected cost of fuel over the vehicles expected life (21).

Simply put, an LCC model should consider all the costs associated with ownership. According to Dr. William Bleuel, there are four elements involved in the total cost of ownership (11:58):

1. Purchase Cost. The cost of capital equipment including installation costs.
2. Operations Cost. The cost of the labor, supplies and other direct expenses required to make use of the equipment.
3. Maintenance Cost. The costs associated with parts, labor and downtime.
4. Disposal Cost. The costs associated with the disposal of obsolete or worn-out capital equipment.

The contributions of these four costs to the total LCC and their relationships to reliability are graphically illustrated in Fig 5. Note that disposal cost is shown as a negative number. This reflects the tendency for capital equipment to have a positive salvage value; that is, its disposal actually generates income and lowers LCC.

Strictly speaking, LCC inputs for operation and maintenance perhaps should be acquired through reliability and maintainability testing, though historical data is generally considered adequate (23:11). In fact, one organization that is intensely interested in ascertaining many different products' LCC values is the Consumers' Union. Their annual analysis of current year automobiles is based partly on

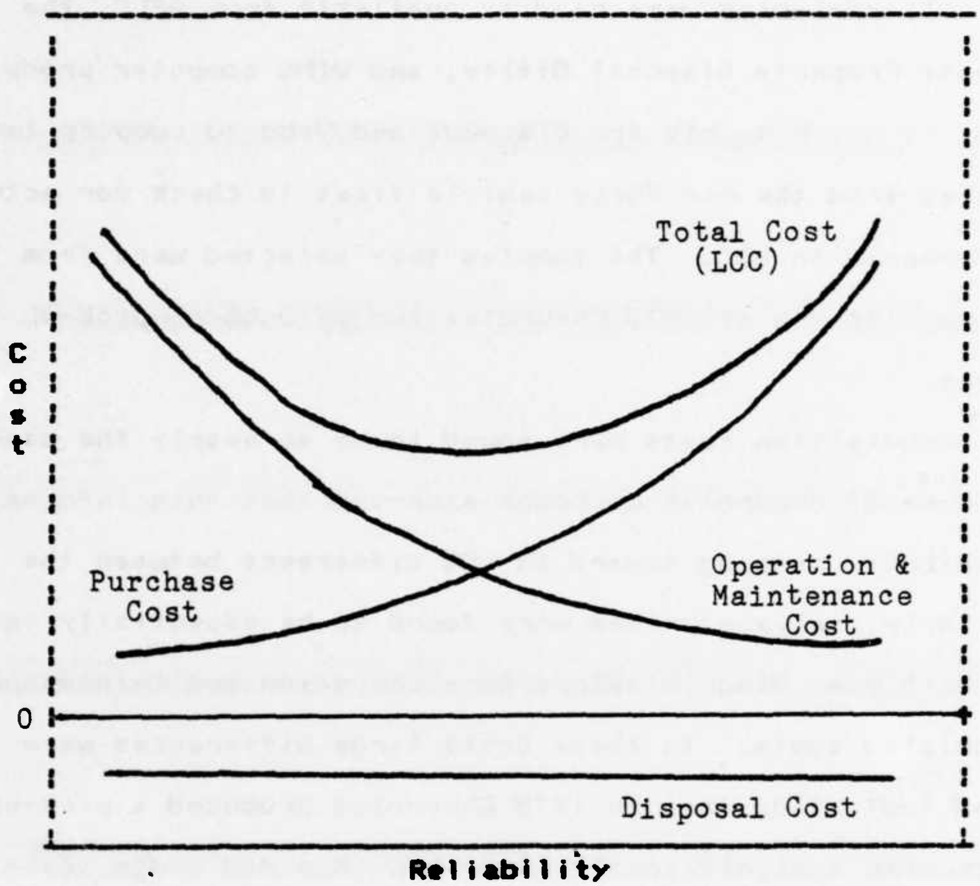

Fig 5. LCC Relationship to Reliability (15:27)

historical data for each particular make (12:205). This is not surprising if one is willing to think of a revised automobile model as an evolutionary, rather than a revolutionary, change from previous years' models.

Research was conducted by Claypool and Webb in an effort to develope an LCC model for Air Force vehicles using historical data exclusively (6:35). Their proposed model was in the form of an equation:

LCC = (ACQUISITION COST) + (LABOR COST) + (MATERIAL COST) + (FUEL COST) + (CONTRACT COST) - (SALVAGE VALUE)

All variables were readily available from AFLC, the Defense Property Disposal Office, and VIMS computer products. Thus, it was possible for Claypool and Webb to compare two samples from the Air Force vehicle fleet to check for actual differences in LCC. The samples they selected were from the two populations of 1975 Chevrolet and 1975 Dodge pick-up trucks.

Acquisition costs were found to be so nearly the same in the case of Chevrolet vs Dodge pick-ups that this information contributed nothing toward an LCC difference between the two. Similarly, salvage values were found to be essentially equal. The only real discriminators were operation and maintenance associated costs. In these costs large differences were found indicating that in 1975 Chevrolet produced a pick-up truck with a significantly lower LCC than did Dodge (6:36). Consequently, one may assume that had public money been directed entirely toward the puchase of Chevrolet pick-ups in 1975 (and no Dodge pick-ups had been purchased at all) a net savings of $4,262,195 would have been realized. Final operation and maintenance (O&M) data from the study is presented below;

Dodge Average Annual O&M Cost..............	$3079.99
Chevrolet Average Annual O&M Cost..........	1862.22
Difference Between the Two Makes...........	1217.77
Air Force Vehicle Life Expectancy..........	X 7
	8524.39
Number of Vehicles Bought..................	X 500
Total Difference........................	$4,262,195.00

Conspicuously absent from Claypool and Webb's LCC model was a means by which to account for and quantify vehicle downtime. The detrimental impact of vehicle downtime on the many systems across an Air Force base that depend on vehicles for mission accomplishment can not be determined with quantitative precision. However, the study noted that Dodge also had greater downtime, thus further widening the LCC gap between the two makes. The importance of downtime to overall maintenance cost merits special attention.

Downtime is a component of maintenance cost. Unlike parts and labor, it is not as easily quantifiable. Downtime cost is the difference between the normal cost of doing business and the costs associated with doing business during periods of mechanical failure. Furthermore, there is a general relationship such that, as parts and labor cost increase, downtime cost decrease (11:59). This relationship is illustrated in Fig 6. Note that at Point A, parts and labor costs are approaching zero, and downtime is becoming infinitely large. At Point B, practically no money is spent on parts and labor, and downtime costs are skyrocketing. Point B is at the other extreme. Here almost no costs are incurred due to downtime, but parts and labor costs, though probably not infinite, are a very large expense. The point to be made is not that the goal of maintenance management should be to eliminate downtime, but to hold it, as well as the cost of labor and parts, at a reasonable level. If the exact cost of downtime could be determined, then the ideal level of maintenance would be one where the cost of parts and labor was just equal to the cost of downtime. At that point, total mainte

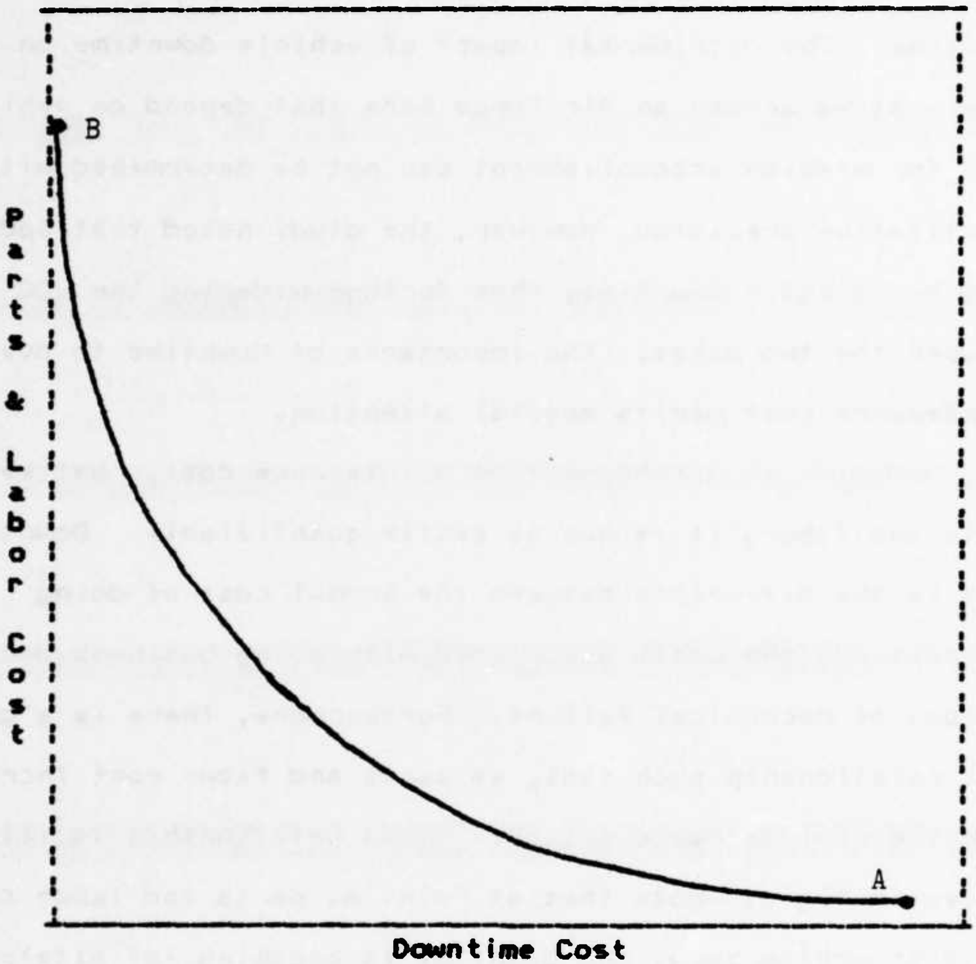

Fig 6. Relation of Parts & Labor Cost to Downtime Cost

nance cost must be minimized. This applies to LCC most directly from the perspective of minimizing total maintenance costs in order to decrease LCC.

<u>The Data Producing Situation</u>

As mentioned in the preceding chapter, the primary difficulty in developing a model to assess the life cycle cost effectiveness of the European Buy Program lies in the developement of operation and maintenance (O&M) data. The best available source of such data is a product of the CAFVIMS reporting system called the Vehicle Management Report (RCS: HAF-LET (SA & A) 7110). This report (henceforth referred to as the 7110 report) is described in detail in AFM 77-310 Volume IV. Essentially, it is produced semi-annually for the purpose of providing MAJCOMs, HQ USAF, and other vehicle managers with a summarized format to monitor O&M costs per mile, Vehicle Out-of-Commission (VOC) rates, and the age of the vehicle fleet. The 7110 report is an aggregation of VIMS generated cost data from the various reporting commands, including USAFE. It is segmented by management codes and further stratified by replacement codes. Management codes correspond to different vehicle types with the types being differentiated on the basis of purpose, weight, fuel, etc. Replacement codes approximate a vehicle's remaining useful life and are used to monitor the vehicle's transition through various stages of its life cycle.

The 7110 report relays mean information, but does not include an assessment of standard deviations. Consequently, the variability of O&M and VOC rates is not known.

Another possible shortcoming of 7110 data concerns the issue of generalizability. The ideal situation might be to work from O&M/VOC data that reflects the costs associated with only one set of vehicles, of the same year group and produced by the same manufacuter, as the set passes through time. The 7110 report actually reflects costs associated with sets of vehicles that are similar enough to each other by official Air Force standards (i.e., they are of the same management code) in various replacement codes.

To its credit, however, the 7110 report reflects actual data on the existing fleets of the various vehicle types. Each vehicle type fleet is composed of an array of different vehicles at different points in their life cycles and, in all likelihood, made by different manufacturers. For instance, the Air Force fleet of pick-up trucks might be composed of Ford vehicles bought this year, the Chevrolet vehicles purchased a year ago, the Dodge vehicles purchased for two consecutive years before that, etc. The resultant menage of assorted manufacturers at disparate, but sometimes merging, points along the vehicle type's life cycle may or may not be similar to the life cycle O&M/VOC costs of one manufacturer's vehicle tracked through time. This is an advantage because these present characteristics of Air Force vehicle fleets are not likely to change in the future. O&M/VOC trends reflected in the current 7110 report should be predictive of future costs. The issue of generalizability is thereby resolved.

III. Methodology

Data Collection

Three kinds of data are used to establish LCCs; acquisition cost data, operation and maintenance cost data, and salvage cost/value data. In addition, authorization and life expectancy figures are necessary for the various vehicle types in order to arrive at the total costs of owning and operating an entirely European-made fleet, or an entirely American-made fleet, for a fixed period of time. The model, used yields a Fleet Annual Life Cycle Cost (FALCC) that represents the total cost of ownership of a given fleet for one year. The model can be expressed in the form of the following equation:

$$FALC = ((DC + O\&M - SV) / LE) * AUTH$$

Where,

FALC = Fleet Annual Life Cycle Cost (the total cost of ownership of a fleet for one year)

DC = Delivered Cost (acquisition plus transportation costs)

O&M = Operation and Maintenance Cost (total O&M cost over the vehicle's life)

SV = Salvage Value

LE = Life Expectancy

AUTH = Authorizations allowed for that vehicle type in the F.R.G., the U.K., and Italy

Delivered Costs

An average delivered cost for the European-made vehicles was developed for each of the 26 vehicle types under consideration. Acquisition costs for the vehicles are taken from a HQ/USAFE report entitled European Vehicle Buy History Report Since Inception, dated June 13, 1984. The report includes unit procurement cost for each vehicle type in each of the three European Buy nations for every year that the type was bought. Because these vehicles are locally purchased and the only transportation involved is within the respective nation, acquisition costs include the cost of transportation (Lamie: add to bib.). The acquisition cost figures used to support the model are the 1983 costs. In instances where there was no receipt of vehicles of a particular type in 1983, the acquisition cost figure used was the most recent cost. That cost was then brought to 1983 dollars using deflator factors taken from the Consumers' Price Index, September editions from 1979 to 1982, published by the Bureau of Labor Statistics.

An acquisition cost figure for each nation in which that vehicle type is purchased locally is input into a weighted averaging scheme where the weights are a function of each applicable nation's total authorization figure for that particular vehicle type. The exact technique for arriving at the authorization figures for the 26 vehicle types under consideration in the nations of the F.R.G., the U.K., and Italy is described later in this section.

For the American-made vehicles, the acquisition cost is calculated as the sum of the procurement cost and the estimated transportation costs. Thus, 26 delivered costs are developed, one to correspond with each of the 26 European costs arrived at through the design described earlier. The American-made vehicles' delivered costs were obtained through the efforts of the office of the system manager for vehicles, Warner Robins ALC/MMTV. Again, all costs are as of 1983. The American acquisition costs, transportation costs, as well as the details of the transportation route and the exact costs associated with it, and delivered costs are outlined in Appendix A.

Operation and Maintenance Costs

Forty operation and maintenance cost figures are needed for the model, one for each of the 20 management codes both European-made and American-made. Each figure must represent the average operation and maintenance cost experienced over the course of that vehicle's useful life.

The 7110 report reflects the culmination of a year's worth of operation and maintenance (O&M) cost data generated over the course of the previous 12 months by all Air Force vehicle maintenance functions. The particularly pertinent aspect of the 7110 report is that portion of Part II relevant to USAFE vehicles. The year's 7110 report of interest is as of September 30, 1983.

VIMS O&M costs are calculated from costs uniformly input from base-level vehicle maintenance activities. These costs are associated primarily with the consumption of fuel (purchased either on- or off-base), oil and lubricants, replacement parts, and direct maintenance hours. The VIMS O&M cost does not include operators' salaries or training costs; these costs may be assumed to be similar regardless of whether the vehicles are European or American manufactured. The cost of downtime, however, is not included in the VIMS O&M cost.

Downtime cost, as discussed earlier, is considered to be an element of maintenance cost and should, in reality, be included in the O&M cost. There is appreciable difficulty and uncertainty surrounding the task of putting into quantitative form (such as dollars) an element that is basically qualitative in nature (the vehicle is either in commission or it is not). Yet, it cannot be altogether ignored. It might be expected that the greater the purchase price, the greater the degree of reliability and, so it follows, the less the percentage of downtime (15:24). The European vehicles generally have a greater purchase price. A conservative approach would be useful to give downtime a quantitative value without risking the introduction of bias in the model in favor of the European vehicles. Such an approach was used by Byrd and Reidy in their preliminmary cost analysis that was a factor in the decision to initiate the European Buy in the F.R.G. That approach will also be used here. The downtime cost and the 7110 report's O&M cost will be united to form the O&M

cost in the model. The reasoning behind their appproach is reproduced here:

> Out-of-commission [Downtime] cost per year - this is the cost of having a vehicle not available for use because of maintenance or spares problems. The cost was derived by applying the Vehicle Out-of-Commission (VOC) rate to the annual ownership cost (delivered cost divided by vehicle life). For example, a vehicle which costs $10,000 delivered and has a ten year life results in an annual ownership cost of $1,000. If that vehicle has a 10% VOC rate, there is 10% of that vehicle, or $100, which is lost to the user because it is not available. This is considered the annual VOC [downtime] cost (22:2).

Salvage Values

Salvage values were determined from data supplied in Bemis and Reidy's 1978 analysis of the U.K. as a potential site for local vehicle purchases (1:Table 1). Their study cites historical salvage values for American and British versions of similar vehicles. The original source of salvage values for the American vehicles was the U.S. Defense Property Disposal Office (D.P.D.O.), Molesworth, England. For the British vehicles, the original source was the British D.P.D.O. equivalent, the U.K. Ordnance Storage and Disposal Depot, Ruddington, England.

Authorizations

Authorizations are the basis for determining expected fleet sizes. In the long run, all authorizations for the appropriate vehicle types will be filled with European manufactured vehicles. Currently , not all authorizations for a

European Buy approved vehicle type are filled with genuinely European vehicles. This is so because of the presence of American manufactured vehicles that were in-place prior to the European Buy decision.

For Air Force installations in the F.R.G., for example, there are 254 authorizations for panel vans (management code B168, if American-made, or F168, if German-made). Since 1979, inclusive, all panel vans purchased for use in the F.R.G. were German-made. The life expectancy for that vehicle type is eight years. Therefore, it would be expected that most, but not all, panel vans in the F.R.G. would be European manufactured.

Authorization figures are used to determine the ultimate size of the European manufactured fleet and the ultimate cost of the fleet. The authorizations for the various vehicle types in the F.R.G., the U.K., and Italy were not readily available from HQ/USAFE, the system manager, or from the various vehicle item managers. Consequently, authorizations were determined for the European Buy nations by using the <u>EMO-DODAAD Cross Reference List</u> in conjunction with the <u>REMS Authorizations and Assets by DODAAD RCS (Format R52)</u> dated 31 May 1984. By gleening all authorization information from a single source, three important advantages were realized:

1) Authorization figures were assured as oppossed to assigned or on-hand figures.

2) Authorizations have the same "as of" date.

3) Authorizations include War Readiness Materiels (WRM) vehicles.

Each Air Force installation has a unique DODAAD identifier number. The DODAAD number for every F.R.G., U.K., and Italian hosted installation were extracted from the EMO-DODAAD Cross-Reference List. These unique identifiers were the key to finding each base's authorizations by each vehicle type from the REMS Authorizations and Assets by DODAAD listing. Authorizations from this listing were in the form of National Stock Numbers, which correspond to management codes. Authorizations for management codes that are not included for local European purchase are not used. Appendix C contains a summation of the vehicle types included in the European Buy Program and the authorizations for each of the three nations. From Appendix C, it can be seen that eventually there will be approximately 9,586 locally manufactured vehicles in the European theater. Of this sum, 5,232 (54.6%) will be German-made; 3,638 (38.0%) will be British-made; and only 716 (7.4%) will be Italian-made.

Life Expectancies

Life Expectancies, the final factor needed to develope FALCCs, are taken directly from A.F.T.O. 36A-1-1301, Vehicle Management Index File. Life expectancies, in years and miles, are recorded in Appendix E, along with warranty information.

Model Development

An LCC model for vehicles must take into account three costs; acquisition, operation and maintenance, and salvage. Life expectancies are necessary to develope one year's total cost. Authorization information is also necessary in order to develope a model that estimates fleet LCC. As mentioned earlier salvage cost is usually reflected by a negative number in the LCC equation because, in the case of vehicles, it generally has a positive value. Each of the three kinds of costs, as well as authorizations, will be addressed later in this section.

Other costs that sometimes appear in an LCC model are the costs associated with research and development and the establishment and operation of a logistics base. Research and developement is included by the manufacturer in the acquisition cost. A logistics base might include such things as maintenance facilities, training for maintenance personnel, tools and equipment, etc. Each of these costs are not a factor in this LCC model, however. The logistics base is essentially the same regardless of whether the vehicles are European or American manufactured.

Delivered Costs

Delivered costs for the European and American vehicles were derived from two different sources. Delivered costs for the American vehicles were obtained from the vehicle system manager, Warner Robins ALC/MMTV. Appendix A contains American delivered costs and explains in detail how they were arrived at.

The European delivered costs were extracted from HQ/USAFE document titled European Vehicle Buy History Report Since Inception dated June 13, 1984. The report details in which nations each vehicle type is locally purchased, what year and how many vehicles of a given type were ordered and received and its unit cost. Since transportation is local within the nation, its cost is included in the purchase price (16).

Appendix B takes pertinent data from the European Buy History Report and converts it into European acquisition costs that are usable in the LCC algorythymn (LCC = Delivered Cost + Operation and Maintenance Cost - Salvage Value). It uses the 1983 reported costs or the most recent cost in lieu of 1983 purchases for every nation from which vehicles were purchased. If necessary, a deflator is used to update the most recent cost to 1983 dollars. The deflator is taken from the Consumers' Price Index for vehicles published by the Bureau of Labor Statistics (29, 30, 31, 32, 33, 34). A weighting scheme is necessary to arrive at average European costs from the F.R.G., the U.K., and Italian costs. The weights used are normalized weights based on authorizations arrived at through a means described earlier (pages 27-28) and reported in Appendix C.

Operation and Maintenance Costs

As discussed earlier, O&M costs are taken from the September 30, 1983, CAFVIMS 7110 report. The 7110 report yields a "snapshot" of the O&M arena, including VOC information, for the entire European theater. It differentiates vehicle types by management codes.

Management codes are three digit numerical codes preceded by an alpha character. The numerical code is a function of the vehicle's purpose, design, weight, engine, and/or other characteristics peculiar to that type of vehicle. If the vehicle is American-made, the alpha character will be either B, C, D, E, K, L, or W depending upon the vehicle's purpose. The alpha and the numeric characters are, to a degree, redundant. If the vehicle is foreign-made the alpha character will be F but the numeric designator remains the same. Since the part of the 7110 report used is Part I, USAFE, all F-prefixed management codes must be European manufactured.

O&M information is further categorized by replacement codes. Replacement codes are used to track vehicles' progress through their expected useful life and as a tool to anticipate necessary fleet replacements. Replacement codes are explained in Air Force Technical Order (A.F.T.O.) 00-25-249, page 5-1, as the means by which to,

> ...identify the status of the fleet for replacement programming. These codes, generated in (VIMS), denote eligibility for immediate replacement or signal the need for programming of funds to permit retirement of vehicles as they become eligible...

Although replacement codes are particularly adept at identifying vehicles within the last year and two years of their expected lives, it also gives useful information regarding the vehicle's mid-point in terms of years and whether the vehicle is still new enough to be under warranty. In effect, replacement codes can be used to distinguish newer vehicles from those that are either older or have accumulated exceptionally high milage (28). Though sometimes the age determination is an approximation, the replacement code is a valuable indicator of a vehicle's remaining useful life.

Appendix E outlines the various replacement codes and their respective criteria. Appendix E was developed from A.F.T.O. 00-25-249. Information relevant to vehicles' life expectancies and warranty periods is contained in Appendix E. Life expectancies were drawn from A.F.T.O. 36A-1-1301.

Replacement code, life expectancy and warranty information are necessary to establish O&M costs, particularly for the European vehicles. Because of the newness of the European Buy Program, no vehicle type fleet has had time to complete a normal life cycle as of September, 1983 (the date of the CAFVIMS 7110 report used for O&M data). Consequently, estimates of life cycle O&M costs are necessary.

The American vehicle types, on the other hand, have a long and established O&M history from the vehicles used in USAFE, including the F.R.G., the U.K., Italy. The 7110 report reflected complete histories for the American-made vehicles in Europe in most cases. These vehicles and their historical O&M/VOC data are the basis on which European-made vehicles' projections are predicated. In cases where American vehicle types in Europe did not have a complete life cycle, because that type had been in Europe for a relatively short time, Air Force American-made vehicles included in the 7110 report (Part I, dated September 30, 1983) served as a basis for projection for both the European and the American vehicles. If an American and European vehicle type did not have a complete history because it was a relatively new vehicle type (i.e., a new management code), and, consequently, did not have a complete history in the world-wide theater, then a similar vehicle type with a complete life cycle history was used as a basis for projection.

The projection technique used requires the assumption that all vehicles of a given type behave similarly over time. That is, their O&M/VOC patterns have similar distributions, though they may have different means. The intuitive justification for this assumption is founded in the many similarities between vehicles of the same type. Though they may have been built by different manufacturers on different continents, the systems involved (mechanical, electrical, hydraulic, pneumatic, etc) are all similar. Engineering, though not identical, is likewise similar. The vehicles are used by similar organizations, perform similar missions, and receive similar maintenance attention. It seems appropriate, then, to assume that O&M/VOC distributions are similar, though they may have different means as a function of overall quality.

The projection technique itself is relatively simple and straightforward. Often, little is known about a European vehicle's O&M/VOC rates at various points in its life cycle because those points have not yet arrived. But, based on the above assumption, what is known about the European vehicle relates to the corresponding American life cycle points in roughly the same way that the total European life cycle O&M/VOC rate relates to the total American life cycle O&M/VOC rate. The only unknown quantity in this relationship is the European vehicle's total life cycle O&M/VOC rate. However, because all other quantities are known, this can be solved for algebraically. Thus, it is possible to arrive at the European vehicle's life cycle O&M/VOC rate.

This relationship can be demonstrated in an example which integrates the concepts of life expectancy in years and miles, warranty period in years, and replacement codes, simultaneously. The purpose is to establish an expected VIMS-generated O&M cost per vehicle mile (excluding VOC cost which is a separate, but similar, calculation) which is later used as a component of an expected European life cycle O&M cost. The European vehicle type is management code F176, European manufactured multistop truck (4X2), and the American type is management code B176, American manufactured multistop truck (4X2), about which there exists complete life cycle information.

(Example)
VIMS-Generated O&M Cost
Calculation for Multistop Truck

Life Expectancy: 7 years; 72,000 miles

Warranty Period: 1 year

Delivered Cost:
American: $20,234
European: $10,447

Replacement Codes:
U (under warranty)
T (between U and R)
R (half-life)
N-Q (within 2 yr. of life)
K-M (within 1 yr. of life)
A-J (life reached or exceeded)

Note that the seven years life expectancy period of encompasses replacement codes U through K only. A-J is outside of the life expectancy. These are vehicles due or past due for salvage. How long a vehicle may stay in such status before actual salvage is unknown. The time spent in A-J status, however, increases the Air Force life expectancy to some larger life expectancy. It must be determined whether not to use any A-J costs and use the Air Force life expectancies, or to somehow estimate the expected period of time an average vehicle will spend in A-J status. The advantage of not using A-J data (and consequently using the Air Force life expectancy) is that it makes the projection process slightly simpler and perhaps less risky.

An analysis of a convenience sample was used to determine whether or not this period of time is likely to have an appreciable impact on O&M costs. The analysis involved averaging the number of years that A-J vehicles (in European Buy qualified management codes) had exceeded the Air Force life expectancy. These data were taken from a convenience sample of all applicable vehicles listed by registration number in the Vehicle Management Report, VIMS listing product control number N310032, for Germany and the United Kingdom obtained from HQ USAFE/LET. It was found that A-J vehicles tend to be about 0.415 years beyond their life expectancy. The percentages of the applicable fleets in A-J replacement codes, as given by the 7110 report, were used to determine the probability that a vehicle might one day be in A-J status. That probability was determined to be 0.171. The expected number of years, then, that the average vehicle will spend in A-J status is given here:

$$0.171 * 0.415 = 0.071$$

To determine whether using this small expected value (Alternative 1) would yield very different results than simply not using A-J data (Alternative 2), the first part of this example (concerned with VIMS-generated O&M costs) considers both alternatives.

Replacement Codes Relationship to Years:

	Alternative 1		Alternative 2	
RC	SPAN	NO. YR.	SPAN	NO. YR.
U	0-1	1	0-1	1
T	1-3.5	2.5	1-3.5	2.5
R	3.5-5	1.5	3.5-5	1.5
N-Q	5-6	1	5-6	1
K-M	6-7	1	6-7	1
Life Expectancy		7		7
A-J	7-8	0.07		
Life Cycle		7.07		7

Note: The number of years that a vehicle can be expected to be in a given replacement code status determines the weight in the below calculation.

Alternative 1

		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1	.28	.28	.16	.16
T	2.5	.17	.425	.19	.475
R	1.5	.41	.615	.24	.36
N-Q	1	.37	.37	.41	.41
K-M	1	.42	.42	Unknown	Unknown
A-J	0.07	.31	2.1317	Unknown	Unknown
	7.07		2.1317		X

Alternative 2

		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1	.28	.28	.16	.16
T	2.5	.17	.425	.19	.475
R	1.5	.41	.615	.24	.36
N-Q	1	.37	.37	.41	.41
K-M	1	.42	.42	Unknown	Unknown
	7		2.11		X

For both alternatives:

RC	AMERICAN COST/MI	EUROPEAN COST/MI
U	.28	.16
T	.425	.475
R	.615	.36
N-Q	.37	.41
	1.690	1.405

The relationships are:

Alternative 1

$$1.690/2.1317 = 1.405/X$$
$$X = 1.772$$

Alternative 2

$$1.690/2.11 = 1.405/Y$$
$$X = 1.754$$

The average cost/mile for the average year is:

Alternative 1

American: 2.1317/7.07 = .306
European: 1.7722121/7.07 = .253

Alternative 2

American: 2.11 = .301
European: 1.7541716/7 = .251

As demonstrated, the average cost/mi arrived at using each of the alternatives are very similar. For this reason and for the sake of simplicity, A-J replacement codes will be omitted from the analysis. Alternative 2 will be employed for the remainder of the analysis.

The expected O&M cost over the life cycle is based on average life cycle cost/mile times expected life cycle miles, where expected miles is 72,000.

American
72,000 * .3014286 = $21,702.86

European
72,000 * .2505959 = $18,042.91

It is possible, then, to derive an expected O&M cost over a vehicle's life cycle. The American cost is based on given data (from CAFVIMS 7110); the European cost is based partly on given data (from the same source) and partly from projection. This, however, gives a cost for VIMS defined O&M, which includes all applicable costs except VOC cost. This important cost can be derived by taking advantage of the relationship previously described, but using VOC rates instead of O&M costs per mile. This will yield an average life cycle VOC rate that can be applied to the vehicle's delivered cost, in accordance with Byrd and Reidy's procedure, to arrive at an estimated cost of downtime.

The downtime cost calculation is illustrated in the following example, again using B/F176, multistop truck, and data from the CAFVIMS 7110.

Downtime Cost Calculation
for Multistop Truck

		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	VOC%	WEIGHTED VOC%	VOC%	WEIGHTED VOC%
U	1	3.62	3.62	7.83	7.83
T	2.5	0.12	0.30	8.54	21.35
R	1.5	15.40	23.10	5.68	8.52
N-Q	1	10.49	10.49	30.06	30.06
K-M	1	15.28	15.28	Unknown	Unknown
	7		52.79		X

RC	AMERICAN VOC%	EUROPEAN VOC%
U	3.62	7.83
T	0.30	21.35
R	23.10	8.52
N-Q	10.49	30.06
	37.51	67.76

The relationship is:

$$37.51/52.79 = 67.76/X$$
$$X = 95.36$$

The average VOC rate is:

AMERICAN: 52.79/7 = 7.54%
EUROPEAN: 95.63/7 = 13.62%

The average VOC rate applied to delivered cost is the estimated cost of downtime:

AMERICAN: 20,234 * .075 = $1.525.64
EUROPEAN: 10,447 * .136 = $1,422.88

The real O&M cost can be found by adding the VIMS-derived O&M cost to the downtime cost:

AMERICAN: 21,702.86 + 1,525.64 = $23,228.50
EUROPEAN: 18,042.91 + 1,422.88 = $19,465.79

Salvage Values

Salvage values for both the European and American vehicles are tabulated in Appendix F. These values were arrived at by applying the percent value from Bemis and Reidy's 1978 cost study for an expansion of the European Buy Program to the United Kingdom (1:Table 1).

It is a matter of addition to use a vehicle's delivered cost, lifetime O&M cost, and salvage value to arrive at the vehicle's LCC. Continuing with the B/F176, multistop truck, example and using the LCC model (Delivered Cost + O&M Cost - Salvage Value = Life Cycle Cost);

American

20,234 + 23,228.50 - 135.05 = $43,327.45

European

10,447 + 19,465.79 - 335.80 = $29,576.99

<u>Authorizations</u>

But simply knowing the total cost associated with a vehicle of a particular type is not enough. It is also necessary to know the expected size of that vehicle type fleet in order to find the anticipated fleet LCC. Thus, it is necessary to know how many vehicles are authorized in the three applicable countries. These authorization figures provide a basis for estimating fleet sizes in a mature European Buy Program.

There are 1,387 authorizations for multistop trucks in the F.R.G, the U.K., and Italy. Were they all to become filled with European-made trucks, the total cost would be $41,023,285. If they were all filled with American-made trucks the total cost would be $60,095,173.

In terms of an annual expense, and since the life expectancy for a multistop truck is seven years, for a European multistop fleet the annual cost would be $41,023,285/7, or $5,860,469. For a fleet of American equivalents the annual cost would be $60,095,173/7, or $8,585,025. The difference between the annual costs is $2,724,556 and the European vehicles appear to be the better buy.

IV. Analysis

It is necessary to omit two vehicle types originally planned to be a part of this analyis. The 1200 gallon gas-oil tank truck (C/F300) and the 4000 pound electric forklift (E/F842) were not included.

The C/F300 did not have a complete life cycle history in Europe or anywhere in the Air Force, according to the 7110 report. The only vehicle comparable to the C/F300 was the C301, also a 1200 gallon gas-oil tank truck, but in a 4X4 drive configuration. The C301, likewise, did not have a complete life cycle history.

The American manufactured electric forklift's VIMS-generated O&M costs are suspect. The only data available are for replacement code R (which receives a weight of 5.5 years in a 15 year life span). In replacement code R, the average cost per hour of operation is $127.36, as opposed to $1.26 for American E842s throughout the Air Force. This $127.36 per hour cost yields a projected life cycle VIMS-generated O&M cost of $2,570,852.60 per American vehicle. In contrast, the same projected cost for European F842s is $149,286.52 per vehicle. It is likely that an error occurred during the input into the VIMS system. Therefore, the E/F842 comparison is omitted from the analysis.

The remaining vehicle types were analyzed following the procedure outlined earlier. The results of the O&M calculations are detailed in Appendices G through X. All of the components to the basic LCC equation for vehicles (Delivered

B121:	$2,552,809	B130:	$1,858,908
F121:	1,844,870	F130:	1,856,287
	$707,939		$2,621
B139:	$24,434	B168:	$1,134,582
F139:	20,761	F168:	777,260
	$3,673		$357,322
B176:	$8,585,024	B185:	$2,232,986
F176:	5,860,469	F185:	1,438,424
	$2,724,555		$794,562
B192:	$225,093	B204:	$9,167,026
F192:	190,940	F204:	7,127,046
	$34,153		$2,039,980
B217:	$3,119,710	B261:	$512,304
F217:	1,861,409	F261:	388,858
	$1,258,301		$123,446
B263:	$3,364,902	C324:	$2,060,510
F263:	1,688,219	F324:	1,576,682
	$1,676,683		$483,828
C332:	$500,151	B353:	$540,525
F332:	380,784	F353:	424,994
	$119,367		$115,331
B361/363:	$6,889,449	E816:	$1,254,704
F361/363:	3,970,476	F816:	1,806,817
	$2,918,973		-$552,113
E822:	$3,991,379	E824:	$176,472
F822:	4,169,804	F824:	188,190
	-$178,425		-$11,718

(Note: F prefixes refer to European vehicles)

Fig 7. FALCCs and Savings
(1983 Dollars)

Cost + Operation/Maintenance Cost - Salvage Value = Life Cycle Cost) are developed.

A more useful tool than the LCC for assessing the year to year costs of the American and European vehicles is the Fleet Annual Life Cycle Cost (FALCC). The FALCC is the average cost associated with a year's worth of ownership of a fleet of a particular kind of vehicle if all of its authorizations were filled by either all American or all European vehicles. The FALCC equation is explained on page 24. This measure of cost is particularly useful in assessing the annual cost of owning fleets of various kinds of vehicles. The FALCCs for the vehicle types analyzed are in Appendix Y,

The projected differences between the American and European vehicles are given in Fig 7. As can be seen, the European vehicles offer a cost savings in almost every management code. The management codes for which there are no projected savings (F816, F822, and F824) correspond to the three types of forklifts studied.

The total annual cost of ownership of the American versions of the 18 vehicle types in Fig 7 is $48,190,968. It is derived by summing the B, C, and E prefixed management codes' FALCCs. Likewise, the sum of the F prefixed management codes is the total annual cost of ownership of the European versions of the same vehicles. The sum of the European FALCCs is $35,572,290.

The savings from the current European Buy Program is the difference between the two sums ($48,190,968 - $35,572,290), $12,618,678 per year. In five years, these savings will accrue to $76,454,324 (5 * $12,618,678). The ten years savings will be $126,186,780 (10 * $12,618,678).

The $12,618,678 per year figure represents a 26.2 percent savings over the cost of an American fleet of the 18 vehicle types. If the three forklifts were eliminated from the program, savings would increase to $13,360,934 per year and the percentage of costs saved would increase to 27.8 percent.

The average difference between an American fleet and a European fleet of the same management code is $701,038 yearly. The average number of authorizations in a fleet is 517.5. Therefore, the average difference between an American and European vehicle is $1,355 ($701,083/517.5) per year.

The average European vehicle's O&M cost is $3,646, but the O&M costs are susceptible to error. In particular, about 39 percent ($1,426) of their value had to be determined by the estimation procedure explained in the chapter on methodology. As previously stated, the average difference between an American and European vehicle is $1,355. The 39 percent of the O&M costs that were estimated would have to be in error by 95 percent (1,355/1,426) to offset that average difference. The total European O&M cost (the 39% estimated and the 61% based on real data) would need to be wrong by 37 percent (1,355/3,646) to offset the difference.

In other words, the estimated 39 percent of the European O&M costs would have to be almost doubled, and the total European O&M cost would have to be increased by over a third, before the European Buy decision would be affected. The European Buy decision is relatively insensitve to the accuracy of life cycle O&M cost projections.

V. Conclusions

The first objective of this study was to determine if differences exist between the annual costs of owning and operating American and European vehicles in the European Buy nations of the F.R.G., the U.K., and Italy. The second objective was to recommend or confirm procurement strategies based on research findings.

In regards to the first objective, the results indicate that there are differences in the annual costs of ownership between typical American and European vehicles operated in the three European Buy nations. The annual cost difference between an American fleet and a European fleet composed of the 18 vehicle types analyzed (see Fig 7) is $12,618,678, where the annual cost of the American fleet is $48,190,968 and of the European fleet is $35,572,290. This represents a cost savings of 26.2 percent. The annual savings for a typical European vehicle type is $701,038. The typical European vehicle costs $13,555 per year less to own and operate than does its American-made counterpart.

The European Buy procurement strategy, while it has been successful, can be improved upon. It is the recommendation of this study that the three forklift management codes analyzed (E/F816, E/F822, and E/F824) be deleted from the European Buy Program. These are the only European vehicle types that cost more to own than their American counterparts. If the forklifts were removed from the program, the benefits would climb from $12,618,678 per year to $13,360,934. This represents a 27.8 percent savings in costs over a similar American fleet. The difference in savings between a European fleet with forklifts and a European fleet without forklifts is $742,256 per year, a 1.6 percent cost reduction.

There were four specific research questions that were asked. Three have already been answered. They pertain to the economic attractiveness of European LCCs, the specific cost differences between European and American fleets, and recommended modifications to the European Buy program.

The fourth research question asked whether an extrapolation could be made, based on available data, about expected European and American LCCs. This study shows one way that LCC projections can be made. The study used delivered costs and salvage values that were based on historical data. The O&M costs were not entirely historical and had more potential for error. LCCs, however, were relatively insensitive to variations in the estimated 39 percent of the O&M value. A 95 percent error was required to impact the European Buy decision. The total O&M value (the historical portion and the estimated portion) had to be in error by 37 percent to affect the decision process.

Several areas not addressed in this study are good candidates for further research. Particularly important are the impacts of;

1) NATO interoperability considerations,

2) American dollar and European currency excange rate fluctuations,

3) Quality improvements in American vehicles,

4) American automobile industry support considerations,

5) European economic considerations.

Though all three are potential intervening variables in the decision process, the issue of interoperability may have the most critical ramifications from a defense perspective. Interoperability is, basically, the interchangeability of parts, components, support equipment, etc. between two systems; such as, the American military vehicle fleet in Europe and the NATO allies' military vehicle fleet. The importance of interoperability is probably best understood, however, in terms of its tactical and stategic value during a major and prolonged conflict in the European theater.

In summary, the European Buy Program should be continued. It is an economic success, but it can be improved by deleting the three forklifts studied.

Appendix A: American Manufactured Vehicles Delivered Costs to Europe (1983 Dollars)

MC:	121	130	139	168	176	185
AC:	28,058	30,966	162,478	7,286	15,215	10,935
TC:	8,113	12,735	10,569	4,883	5,019	2,444
DC:	36,171	43,701	173,047	12,169	20,234	13,741

MC:	192	204	217	261	263	300
AC:	10,558	5,754	9,017	7,547	21,470	35,000
TC:	3,827	4,279	4,724	4,404	6,542	4,922
DC:	14,385	10,033	13,741	11,951	28,012	39,922

MC:	324	332	353	361/363	816	822
AC:	32,267	43,360	34,787	47,560	15,292	28,357
TC:	5,675	6,947	6,082	7,789	2,388	4,917
DC:	37,942	50,307	40,869	55,349	17,680	33,274

MC:	824	842
AC:	37,237	23,200
TC:	7,996	2,836
DC:	43,233	26,036

MC = Management Code AC = Acquisition Cost
TC = Transportation Cost DC = Delivered Cost

AC + TC = DC

Acquisition costs are as of 1983 and were obtained through the Office of the System Manager of Vehicles (Robins ALC/MMTV).

Transportation costs are from St. Louis, MO, to Ramstein A.F.B., F.R.G., via the ports of Norfolk, VA, and Bremerhavenx, F.R.G. The over-the-road transportation (rail) from St. Louis to Norfolk is calculated at the rate of $1.15 per mile for 895 miles. A port handling cost of $35.35 per vehicle is incurred at Norfolk. The cost of the sea leg is estimated at $140.20 per measurement ton (a measurement ton is equal to 40 cubic feet). At Bremerhavenx an additional &35.35 per vehicle port handling charge is incurred. The final over-the-road leg is from Bremerhavenx to Ramstein A.F.B., a distance of 246 miles also at $1.15 per mile.

In reality, the vehicles might be purchased at many different sites in the U.S. Final delivery may be to any Air Force installation in the F.R.G., the U.K., or Italy. St. Louis and Ramstein, A.F.B., were chosen, upon the advice of the System Manager for Vehicles, because they are representative in terms of being probable and in the approximate center of each region. Note that in Appendix B the preponderance of Air Force vehicle authorizations in the F.R.G.

Appendix B: European Manufactured Vehicles Costs

MC	NAT	COST/YR	DEFL	83 COST	N WT	N COST
121	FRG	30,131/83		30,131	.539	$16,241
	UK	26,664/83		26,664	.461	12,292
					TOTAL;	$28,533
130	FRG	75,092/83		75,092	.573	$43,028
	UK	44,149/83		44,149	.427	18,852
					TOTAL:	$61,880
139	FRG	134,282/80	1.1573	155,405	1.000	$155,405
					TOTAL:	$155,405
168	FRG	7,765/83		7,765	.674	$5,234
	IT	8,510/82	0.9942	8,461	.055	465
	UK	6,215/83		6,215	.271	1,684
					TOTAL;	$7,383
176	FRG	11,841/83		11,841	.446	$5,281
	IT	11,841/83		11,841	.085	1,006
	UK	8,870/83		8,870	.469	4,160
					TOTAL:	$10,447
185	FRG	7,568/83		7,568	.547	$4,140
	IT	9,162/82	0.9942	9,109	.099	902
	UK	6,508/83		6,508	.354	2,304
					TOTAL:	$7,346
192	FRG	13,229/82	0.9942	13,152	.544	$7,155
	IT	10,430/82	0.9942	10,370	.158	1,638
	UK	12,985/83		12,985	.298	3,870
					TOTAL:	$12,663

MC	NAT	COST/YR	DEFL	83 COST	N WT	N COST
204	FRG	7,420/83		7,423	.493	$3,660
	IT	8,316/82	0.9942	8,268	.088	728
	UK	8,581/83		8,581	.419	3,579
					TOTAL:	$7,967
217	FRG	7,383/83		7,383	.868	$6,408
	IT	8,806/82	0.9942	8,755	.132	1,156
					TOTAL:	$7,564
261	UK	10,052/82	0.9942	9,994	1.000	$9,994
					TOTAL:	$9,994
263	FRG	10,227/83		10,227	.543	$5,553
	IT	12,097/83		12,097	.087	1,052
	UK	11,771/79	1.3124	15,448	.370	5,716
					TOTAL:	$12,321
300	FRG	20,117/83		20,117	1.000	$20,117
					TOTAL:	$20,117
324	FRG	45,264/83		45,264	.572	$25,891
	UK	22,000/81	1.0333	22,733	.428	9,730
					TOTAL:	$35,621
332	FRG	36,326/81	1.0333	37,536	.833	$31,267
	UK	52,500/83		52,500	.167	8,768
					TOTAL:	$40,035
353	FRG	31,777/81	1.0333	32,835	.649	$21,310
	UK	24,000/83		24,000	.351	8,424
					TOTAL:	$29,734

MC	NAT	COST/YR	DEFL	83 COST	N WT	N COST
361/363	FRG	45,264/83		45,264	.537	$24,307
	UK	38,549/83		38,549	.463	17,848
					TOTAL:	$42,155
816	FRG	23,543/83		23,543	.513	$12,078
	IT	17,712/82	1.0211	18,086	.028	506
	UK	23,532/83		23,532	.459	10,801
					TOTAL:	$23,385
822	FRG	29,681/83		29,681	.557	$16,532
	IT	22,450/83		22,450	.090	2,021
	UK	34,954/81	1.0667	37,285	.353	13,162
					TOTAL:	$31,715
824	FRG	47,058/81	1.0667	50,197	.479	$24,044
	IT	35,866/81	1.0667	38,258	.130	4,974
	UK	30,776/81	1.0667	32,829	.391	12,836
					TOTAL;	$45,854
842	FRG	19,734/83		19,734	.294	$5,802
	UK	29,345/82	1.0211	29,964	.706	21,155
					TOTAL:	$26,957

MC = Management Code

NAT = Applicable Nations (the nations in which a particular vehicle type is purchased locally)

COST/YR = Most recent Cost and Year (the most recent acquistion cost paid and the corresponding year)

DEFL = Deflator (the deflator used to bring the most recent cost into 1983 dollars, taken from the Consumers' Price Index published by the Bureau of Labor Statistics) (29, 30, 31, 32, 33 ,34)

83 COST = The most recent cost updated to 1983 dollars via a deflator

N WT = Normalized Weight based on the number of authorizations (not assignments) in each nation for a given vehicle type.

N COST = Normalized Cost arrived at by applying the normalized weight to the 1983 cost. The normalized costs can then be added to form a figure that represents the average acquisition cost (in 1983 dollars) of a given vehicle type in all of Europe.

Appendix C: Federal Republic of Germany, United Kingdom, and Italian Vehicle Authorizations

NOMENCLATURE	MC	FRG	UK	IT	TOTAL
Bus, school, 25-29 pax, 4x2, diesel	121	215	184	NA	399
Bus, school, 42-45 pax, 4x2, diesel	130	126	94	NA	220
Bus, intercity, 41-51 pax, 4x2, diesel	139	1	NA	NA	1
Truck, panel, 4x2, 6,999# gross & under	168	254	102	21	377
Truck, multistop, 4x2, 7000# gross	176	619	650	118	1,387
Truck, carry-all, 4x2, 6999# gross & under	185	374	242	68	684
Truck, carry-all, 4x2, 15 pax, 7700# gross	192	31	17	9	57
Truck, pick-up, 3 pax, 4x2, 4600-5799# gross	204	1,402	1,189	250	2,841
Truck, pick-up, 6 pax, 4x2, 5800# gross	217	688	NA	105	793
Truck, 1 ton, stake & platform, 4x2, 7000# gross, gasoline	261	NA	145	NA	145
Truck, 1 1/2 ton, stake & platform, 4x2, 12,500-16,999# gross	263	323	220	52	595
Truck, tank, gas-oil, 1200 gal., 4x2	300	52	NA	NA	52
Truck, dump, 5 ton, 4x2, 24,000-27999# gross	324	111	83	NA	194

NOMENCLATURE	MC	FRG	UK	IT	TOTAL
Truck, dump, 4x4, 24,000-33,999# gross	332	35	7	NA	42
Truck, tractor, 4x2, 24,000-44,500# gross, diesel	353	37	20	NA	57
Truck, tractor, 6x4, 24,000# gross & over, diesel	361/ 363	260	214	NA	474
Truck, forklift, 4000# gross, diesel	816	143	128	8	279
Truck, forklift, 6,000# gross, diesel	822	416	264	67	747
Truck, forklift, 15,000# gross	824	11	9	3	23
Truck, forklift, 4000-5999# gross, electric	842	5	12	NA	17
	TOTALS;	5,232	3,638	716	9,586

MC = Air Force assigned management code encompassing all vehicles of similar type, purpose, passenger (pax) capacity, gross weight, drive axles, engine type, etc.

NA = Not Applicable; though the nation may have authorizations for this vehicle type, the type is not permitted to be purchased locally; i.e., all authorizations of this type are filled with American manufactured vehicles.

All authorization figures were extracted from the REMS Authorizations and Assets by DODAAD listing (Format R52) dated May 31, 1984. The net effect of extracting authorization figures from this listing is that it was made possible to uncover authorizations per any given National Stock Number for any DODAAD number. National Stock Numbers were then converted to vehicle management codes. DODAAD numbers were equated to Air Force installations using the EMO-DODAAD Cross-Reference List.

Appendix D: Vehicle Life Expectancies and Warranty Periods

MGT CODE	LIFE YEARS	LIFE MILES/HOURS	WARRANTY YEARS	WARRANTY MILES/HOURS
121	14	200,000 mi.	1	12,000 mi.
130	14	200,000 mi.	1	12,000 mi.
139	12	300,000 mi.	1	12,000 mi.
168	8	72,000 mi.	1	12,000 mi.
176	7	72,000 mi.	1	12,000 mi.
185	7	72,000 mi.	1	12,000 mi.
192	8	100,000 mi.	1	12,000 mi.
204	7	72,000 mi.	1	12,000 mi.
217	8	72,000 mi.	1	12,000 mi.
261	8	72,000 mi.	1	12,000 mi.
263	9	84,000 mi.	1	12,000 mi.
300	15	NO LIMIT	1	12,000 mi.
324	10	84,000 mi.	1	12,000 mi.
332	10	84,000 mi.	1	12,000 mi.
353	10	150,000 mi.	1	15,000 mi.
361	12	150,000 mi.	1	15,000 mi.
363	12	150,000 mi.	1	15,000 mi.
816	8	9,000 hr.	1	NO LIMIT
822	10	9,000 hr.	1	NO LIMIT
824	10	12,000 hr.	1	NO LIMIT
842	15	18,000 hr.	1	NO LIMIT

Appendix E: Vehicle Replacement Codes

RC	CRITERIA
U	Vehicle is under new/remanufactured warranty.
T	Assigned when codes A through U do not apply. In effect, when vehicle lies between U and R.
R	Vehicle has reached or exceeded half of its programmed life expectancy in years.
Q	Vehicle will reach its life expectancy in miles within two years.
P	Vehicle will reach its life expectancy in years within two years.
N	Vehicle will reach its life expectancy in miles and years within two years.
M	Vehicle will reach its life expectancy in miles within one year.
L	Vehicle will reach its life expectancy in years within one year.
K	Vehicle will reach its life expectancy in miles and years within one year.
J	Vehicle has reached or exceeded its life expectancy in miles.
H	Vehicle has reached or exceeded its life expectancy in years.
G	Vehicle has reached or exceeded its life expectancy in miles and years.
D	Vehicle has reached or exceeded its One-Time Repair Limit.
C	Vehicle has reached or exceeded its life expectancy in miles and its One-Timme Repair Limit.

RC	CRITERIA
B	Vehicle has reached or exceeded its life expectancy in miles, years, and its One-Time Repair Limit.

These replacement codes and their criteria are taken from A.F.T.O. 00-25-249, Vehicle Management Index File, page 5-1.

Appendix F: Salvage Values
(1983 Dollars)

MC		78SV/78DC = SV% * 83DC = 83SV
121	US:	196/26,273 = .746% * 36,171 = 269.84
	UK:	336/31,391 = 1.070% * 28,533 = 305.41
130	US:	280/32,383 = .865% * 43,701 = 377.86
	UK:	1,498/34,607 = 4.329% * 61,880 = 2,678.54
139	US:	3.506% * 173,047 = 6,066.26
	UK:	8.550% * 155,405 = 13,287.13

Note: The source for these salvage values did not include an analysis of B/F139, consequently there are no 1978 salvage values or delivered costs. The salvage percentages used here for B/F139 are the means of the other vehicle types.

168	US:	152/7,404 = 2.033% * 12,169 = 249.82
	UK:	544/5,259 = 10.344% * 7,383 = 763.71
176	US:	56/8,390 = .667% * 20,234 = 135.05
	UK:	288/8,960 = 3.214% * 1,0447 = 335.80
185	US:	273/8270 = 3.301% * 13,397 = 442.25
	UK:	602/6,341 = 9.494% * 12,663 = 1202.20
192	US:	104/10,738 = .969% * 14,385 = 139.32
	UK:	688/8,414 = 8.177% * 12,663 = 1,035.43
204	US;	252/5790 = 4.352% * 10,033 = 436.67
	UK:	476/4,025 = 11.826% * 7,967 = 942.18
217	US:	344/7,359 = 4.675% * 13,741 = 642.33
	UK:	288/6,614 = 4.354% * 7,564 = 329.37
261	US:	451/10,615 = 4.249% * 11,951 = 507.76
	UK:	502/9,547 = 5.258% * 9,994 = 525.50
263	US:	451/10,615 = 4.249% * 28,012 = 1,190.15
	UK:	502/9,547 = 5.2587% * 12,321 = 647.86

Note: B/F261 and B/F263 use the same 1978 salvage values and delivered costs. This is because the 1978 source study combined the two vehicle types.

300	US;	1,020/26,803 = 3.806% * 39,922 = 1,519.25
	UK:	1,935/30,612 = 6.321% * 20,117 = 1,271.61
324	US:	230/16,012 = 1.436% * 37,942 = 545.01
	UK:	1,420/13,137 = 10.809% * 35,621 = 3,850.33
332	US:	190/22,107 = .859% * 50,307 = 432.37
	UK:	2,990/22,290 = 17.900% * 40,035 = 7,166.43
353	US:	530/16,012 = 3.310% * 40,869 = 1,352.77
	UK:	850/13,137 = 6.475 * 29,734 = 1,925.33
361/	US:	1,848/33,651 = 5.492% * 55,349 = 3,039.58
363	UK:	1,032/13,137 = 7.856% * 42,155 = 3,311.56
816	US:	1,000/12,661 = 7.898% * 17,680 = 1,396.41
	UK:	2,240/15,877 = 14.108% * 23,385 = 3,299.26
822	US:	1,500/16,137 = 9.295% * 33,274 = 3,092.95
	UK:	3,260/16,181 = 20.147% * 31,715 = 6,389.65
824	US:	1,000/30,690 = 3.258% * 43,233 = 1,408.70
	UK:	6,920/28,114 = 24.614% * 45,854 = 11,286.54
842	US:	1,005/17,661 = 5.691% * 26.036 = 1,481.58
	UK:	1,303/17,233 = 7.573% * 26,957 = 2,041.37

MC = Management Codes
78SV = 1978 Salvage Values
78DC = 1978 Delivered Costs
SV% = 78SV divided by 78DC (expressed as a percentage)
83DC = 1983 Delivered Costs
83SV = 1983 Salvage Values

Appendix G: Life Cycle O&M Cost Calculation for B/F121 (25-29 pax Bus)

In this calculation it was necessary to base projections on American-made vehicles throughout the Air Force (AF/American) because there was no complete life cycle yet for either American vehicles in Europe or for European vehicles.

Life Expectancy: 14 years; 200,000 miles.

Warranty Period: 1 year.

Delivered Cost:
American: $36,171
European: $28,533

VIMS-Generated O&M Cost

		AF/AMERICAN		AMERICAN		EUROPEAN	
R/C	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1.0	.25	.25	.18	.18	.16	.16
T	6.0	.29	1.74	.25	1.50	.16	.96
R	5.0	.25	1.25	Unknown	Unknown	Unknown	Unknown
N-Q	1.0	.53	.53	"	"	"	"
K-M	1.0	.32	.32	"	"	"	"
			4.09		X		Y

The relationship is:

$$1.99/4.09 = 1.68/X = 1.12/Y$$
$$X = 3.4528643$$
$$Y = 2.3019095$$

The expected VIMS-generated life cycle O&M costs are:

American: X/14 * 200,000 = 49,326.63
European: Y/14 * 200,000 = 32,884.42

Downtime Cost

		AF/AMERICAN		AMERICAN		EUROPEAN	
	YEAR/		WEIGHTED		WEIGHTED		WEIGHTED
RC	WEIGHT	VOC%	VOC%	VOC%	VOC%	VOC%	VOC%
U	1.0	7.36	7.36	0.00	0.00	12.88	12.88
T	6.0	14.41	86.46	15.55	93.30	14.28	85.68
R	5.0	5.38	26.90	Unknown	Unknown	Unknown	Unknown
N-Q	1.0	20.48	20.48	"	"	"	"
K-M	1.0	27.89	27.89	"	"	"	"
			169.09		X		Y

The relationship is:

93.82/169.09 = 93.30/X = 98.56/Y
X = 168.15281
Y = 177.63281

The life cycle costs of downtime are:

American: 36,171 * X/100/14 = 4,344.47
European: 28,533 * Y/100/14 = 3,620.28

And the total life cycle O&M costs are:

American: 49,326.63 + 4,344.47 = $53,671.10
European: 32,884.42 + 3,620.28 = $36,504.70

Appendix H: Life Cycle O&M Cost Calculation for B/F130 (42-45 pax Bus)

Neither American (in Europe or worldwide) nor European vehicles of this type have a complete life cycle cost. A similar vehicle type, B121 (25-29 pax school bus), however, does have a complete life cycle in the worldwide theater. The life cycle data from B121s throughout the Air Force (AF/AMER-121) serve as the basis for these projections.

Life Expectancy: 14 years; 200,000 miles.

Warranty Period: 1 year.

Delivered Cost:

American: $43,701
European: $61,880

VIMS-Generated O&M Cost

		AF/AMER-121		AMERICAN		EUROPEAN	
R/C	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1.0	.25	.25	Unknown	Unknown	.27	.27
T	6.0	.29	1.74	.34	2.04	.25	1.50
R	5.0	.25	1.25	Unknown	Unknown	Unknown	Unknown
N-Q	1.0	.53	.53	"	"	"	"
K-M	1.0	.32	.32	"	"	"	"
			4.09		X		Y

The relationships are:

$$1.74/4.09 = 2.04/X$$
$$X = 4.7951724$$

$$1.99/4.09 = 1.77/Y$$
$$Y = 3.6378392$$

The life cycle VIMS-generated O&M costs are:

American: X/14 * 200,0000 = $68,502.46
European: Y/14 * 200,000 = $51,969.13

Downtime Cost

		AF/AMER-121		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	VOC%	WEIGHTED VOC%	VOC%	WEIGHTED VOC%	VOC%	WEIGHTED VOC%
U	1.0	7.36	7.36	Unknown	Unknown	12.75	12.75
T	6.0	14.41	86.46	17.66	105.96	12.43	74.58
R	5.0	5.38	26.90	Unknown	Unknown	Unknown	Unknown
N-Q	1.0	20.48	20.48	"	"	"	"
K-M	1.0	27.89	27.89	"	"	"	"
			169.09		X		Y

The relationships are:

$$86.46/169.09 = 105.96/X$$
$$X = 207.22619$$

$$93.82/169.09 = 87.33/Y$$
$$Y = 157.3932$$

The life cycle downtime costs are:

American; 43,701 * X/100/14 = $6,468.57
European: 61,880 * Y/100/14 = $6,956.78

The total life cycle O&M costs are:

American: 68,502.46 + 6,468.57 = $74,971.01
European: 51,969.13 + 6,956.78 = $58,925.91

Appendix I: Life Cycle O&M Cost Calculation for B/F139 (Intercity Bus)

In this calculation it was necessary to base projections on American-made vehicles throughout the Air Force (AF/AMERICAN) because there was not a complete life cycle yet for European-made vehicles and no data at all on American vehicles in Europe. It is assumed that American vehicles worldwide (AF/AMERICAN) would approximate American vehicles in Europe.

Life Expectancy: 12 years; 300,000 miles.e

Warranty Period: 1 year.

Delivered Cost:
American: $173,047
European: $155,405

VIMS-Generated O&M Costs

		AF/AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1	.27	.27	Unknown	Unknown
T	5	.21	1.05	.21	1.05
R	4	.47	1.88	Unknown	Unknown
N-Q	1	.57	.57	"	"
K-M	1	.43	.43	"	"
			4.20		X

The relationship is:

$$1.05/4.20 = 1.05/X$$
$$X = 4.20$$

The expected VIMS-generated life cycle O&M costs are:

American: 4.20/12 * 300,000 = $105,000.00
European: 4.20/12 * 300,000 = $105,000.00

Downtime Cost

		AF/AMERICAN		EUROPEAN	
	YEAR/	O&M	WEIGHTED	O&M	WEIGHTED
RC	WEIGHT	COST/MI	COST/MI	COST/MI	COST/MI
U	1	1.55	1.55	Unknown	Unknown
T	5	12.31	61.55	1.30	6.50
R	4	11.57	46.28	Unknown	Unknown
N-Q	1	27.29	27.29	"	"
K-M	1	10.49	10.49	"	"
			147.16		X

The relationship is:

$$61.55/147.16 = 6.50/X$$
$$X = 15.540861$$

The life cycle costs of downtime are:

American: 173,047 * 147.16/100/12 = \$21,221.33
European; 155,405 * X/100/12 = \$2,012.61

And the total life cycle O&M costs are:

American: 105,000.00 + 21,221.33 = \$126,221.33
European: 105,000.00 + 2,012.61 = \$107,012.61

Appendix J: Life Cycle O&M Cost Calculation for B/F168 (Panel Truck)

Life Expectancy: 8 years; 72,000 miles.

Warranty Period: 1 year.

Delivered Cost:
American: $12,169
European: $7,383

VIMS-Generated O&M Cost

		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1	.07	.07	.07	.07
T	3	.22	.66	.15	,45
R	2	.27	.54	.36	.72
N-Q	1	.25	.25	.08	.08
K-M	1	.12	.12	.18	.18
			1.64		1.50

The expected VIMS-generated life cycle O&M costs are:

American: 1.82/8 * 72,000 = $16,380.00
European: 1.50/8 * 72,000 = $13,500.00

Downtime Cost

		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	VOC%	WEIGHTED VOC%	VOC%	WEIGHTED VOC%
U	1	0.00	0.00	3.17	3.17
T	3	10.12	30.36	6.57	19.71
R	2	16.37	32.74	6.22	12.44
N-Q	1	11.06	11.06	0.20	0.20
K-M	1	13.15	3.15	0.00	.00
			87.31		35.52

The life cycle costs of downtime are:

American: 12,169 * 87.31/100/8 = $1,328.09
European: 7,383 * 35.52/100/8 = $387.81

Appendix K: Life Cycle O&M Cost Calculation for B/F176 (Multistop Truck)

The mechanics of this set of calculations is documented in an earlier chapter. Multistop trucks served as an example to explain these procedures. The life cycle O&M costs previously arrived at in the chapter on methodology are:

American: $23,228.50

European: $19,465.79

Appendix L: Life Cycle O&M Cost Calculation for B/F185 (9 pax Carry-All)

In this calculation the American vehicles in Europe projections are based data from American vehicles throughout the Air Force (AF/AMERICAN) due to insufficient life cycle data for the American vehicles in Europe.

Life Expectancy: 7 years; 72,000 miles.

Warranty Period: 1 year.

Delivered Cost:
American: $13,397
European: $7,346

VIMS-Generated O&M Cost

		AF/AMERICAN		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1.0	.14	.14	Unknown	Unknown	.09	.09
T	2.5	.15	.375	Unknown	Unknown	.13	.325
R	1.5	.22	.33	.23	.345	.15	.225
N-Q	1.0	.17	.17	.19	.19	.15	.15
K-M	1.0	.16	.16	.14	.14	.17	.17
			1.175		X		.96

The relationship is:

.85/1.175 = .855/X
X = 1.1819118

The life cycle VIMS-generated O&M costs are:

American: X/7 * 72,000 = $12,156.81
European: .96/7 * 72,000 = $9,874.29

Downtime Cost

RC	YEAR/ WEIGHT	AF/AMERICAN VOC%	AF/AMERICAN WEIGHTED VOC%	AMERICAN VOC%	AMERICAN WEIGHTED VOC%	EUROPEAN VOC%	EUROPEAN WEIGHTED VOC%
U	1.0	2.09	2.09	Unknown	Unknown	1.51	1.51
T	2.5	6.11	15.275	Unknown	Unknown	11.99	29.975
R	1.5	8.92	13.38	14.92	22.38	6.80	10.20
N-Q	1.0	7.43	7.43	10.75	10.75	23.39	23.39
K-M	1.0	8.84	8.84	18.78	18.78	20.69	20.69
			47.005		X		76.765

The relationship is:

$$29.65/47.005 = 33.13/X$$
$$X = 52.521944$$

The life cycle costs of downtime are:

American: 13,397 * X/100/7 = $1,005.20
European: 7,346 * 76.765/100/7 = $805.59

The total life cycle O&M costs are:

American: 12,156.81 + 1,005.20 = $13,162.01
European: 9,874.29 + 805.59 = $10,679.88

Appendix M: Life Cycle O&M Cost Calculation for B/F192 (15 pax Carry-All)

Because of lack of a complete life cycle in both European and American vehicles in Europe, projections are based on data from American vehicles Air Force wide.

Life Expectancy: 8 years; 100,000 miles.

Warranty Period: 1 year.

Delivered Cost:
American: $14,385
European: $12,663

VIMS-Generated O&M Cost

		AF/AMERICAN		AMERICAN		EUROPEAN	
RC	YARD/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1	.13	.13	Unknown	Unknown	.14	.14
T	3	.18	.54	.15	.45	.14	.42
R	2	.22	.44	.15	.30	Unknown	Unknown
N-Q	1	.20	.20	.21	.21	.14	.14
K-M	1	.21	.21	.16	.16	.19	.19
			1.52		X		Y

The relationship is:

$$1.39/1.52 = 1.12/X$$
$$X = 1.2247482$$

$$1.08/1.52 = .89/Y$$
$$Y = 1.2525926$$

The VIMS-generated life cycle O&M costs are:

American: X/8 * 100,000 = $15,309.35
European: Y/8 * 100,000 = $13,657.41

Downtime Cost

		AF/AMERICAN		AMERICAN		EUROPEAN	
	YEAR/		WEIGHTED		WEIGHTED		WEIGHTED
RC	WEIGHT	VOC%	VOC%	VOC%	VOC%	VOC%	VOC%
U	1	2.55	2.55	Unknown	Unknown	1.92	1.92
T	3	6.99	20.97	14.19	42.57	12.32	36.96
R	2	10.93	21.86	22.69	45.38	Unknown	Unknown
N-Q	1	11.80	11.80	18.05	18.05	13.09	13.09
K-M	1	12.59	.2.59	3.14	.14	13.70	3.70
			69.77		X		Y

The relationships are:

$$67.22/69.77 = 109.14/X$$
$$X = 113.28024$$

$$47.91/69.77 = 65.67/Y$$
$$Y = 95.633394$$

The life cycle costs of downtime are:

American: 14,385 * X/100/8 = $2,036.92
European: 12,663 * Y/100/8 = $1,513.76

The life cycle O&M costs are:

American: 15,309.35 + 2,036.92 = $17,346.27
European: 13,657.41 + 1,513.76 = $15,171.17

Appendix N: Life Cycle O&M Cost Calculation for B/F204 (3 pax Pick-Up Truck)

No projections were necessary. Complete life cycle data was available for both European and American.

Life Expectancy: 7 years; 72,000 miles.

Warranty Period: 1 years.

Delivered Cost:
American: $10,033
European: $7,967

VIMS-Generated O&M Cost

RC	YEAR/ WEIGHT	AMERICAN O&M COST/MI	AMERICAN WEIGHTED COST/MI	EUROPEAN O&M COST/MI	EUROPEAN WEIGHTED COST/MI
U	1.0	.06	.06	.08	.08
T	2.5	.17	.425	.18	.45
R	1.5	.16	.24	.17	.255
N-Q	1.0	.17	.17	.09	.09
K-M	1.0	.29	.29	.10	.10
			1.185		.975

The VIMS-generated life cycle O&M costs are identical:

American: 72,000 * 1.185/7 = $12,188.57
European: 72,000 * .957 = $10,028.57

Downtime Cost

RC	YEAR/ WEIGHT	AMERICAN VOC%	AMERICAN WEIGHTED VOC%	EUROPEAN VOC%	EUROPEAN WEIGHTED VOC%
U	1.0	.31	.31	.06	.06
T	2.5	9.38	23.45	9.93	24.825
R	1.5	6.16	9.24	6.02	9.03
N-Q	1.0	9.46	9.46	10.64	10.64
K-M	1.0	13.49	13.49	0.00	0.00
			55.95		44.555

The life cycle costs of downtime are:

American: 10,033 * 55.95/100/7 = $801.92
European: 7,967 * 44.555/100/7 = $507.10

The total life cycle O&M costs are:

American: 12,188.57 + 801.92 = $12,990.49
European: 10,028.57 + 507.10 = $10,535.67

Appendix O: Life Cycle O&M Cost Calculation for B/F217 (6 pax Pick-Up Truck, 4X2)

No projections were necessary as complete life cycle data were available for both American and European vehicles.

Life Expectancy: 8 years; 72,000 miles.

Warranty Period: 1 year.

Delivered Cost:
American: $13,741
European: $7,564

VIMS-Generated O&M Cost

		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1	.15	.15	.12	.12
T	3	.17	.51	.15	.45
R	2	.28	.56	.08	.16
N-Q	1	.35	.35	.19	.19
K-M	1	.30	.30	.31	.31
			1.87		1.23

The VIMS-generated life cycle O&M costs are:

American: 1.87/8 * 72,000 = $16,830.00
European: 1.23/8 * 72,000 = $11,070.00

Downtime Cost

		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	VOC%	WEIGHTED VOC%	VOC%	WEIGHTED VOC%
U	1	0.91	0.91	0.14	0.14
T	3	9.76	29.28	9.47	28.41
R	2	13.27	26.54	0.00	0.00
N-Q	1	19.07	19.07	7.37	7.37
K-M	1	14.08	14.08	14.19	14.19
			89.88		50.11

The life cycle cost of downtime are:

American: 13,741 * 89.88/100/8 = $1,543.80
European: 7,564 * 50.11/100/8 = $473.79

The total life cycle O&M costs are:

American: 16,830 + 1,543.80 = $18,373.80
European: 11,070 + 473.79 = $11,543.79

Appendix P: Life Cycle O&M Cost Calculation for B/F261 (1 ton Stake & Platform Truck)

Life Expectancy: 8 years; 72,000 miles.

Warranty Period: 1 year.

Delivered Costs:
- American: $11,951
- European: $9,994

VIMS-Generated O&M Cost

		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1	.29	.29	.15	.15
T	3	.19	.57	.14	.42
R	2	.32	.64	Unknown	Unknown
N-Q	1	.08	.08	Unknown	Unknown
K-M	1	.29	.29	Unknown	Unknown
			1.81		X

The relationship is:

$$.86/1.81 = .57/X$$
$$X = 1.1996512$$

The VIMS-generated life cycle O&M costs are:

American: 1.81/8 * 72,000 = $16,290
European: X/8 * 72,000 = $10,796.86

Downtime Cost

		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	VOC%	WEIGHTED VOC%	VOC%	WEIGHTED VOC%
U	1	2.13	2.13	10.25	10.25
T	3	3.31	9.93	7.33	21.99
R	2	5.22	10.44	Unknown	Unknown
N-Q	1	5.78	5.78	"	"
K-M	1	7.32	7.32	"	"
			35.60		X

The relationship is:

$$12.06/35.60 = 32.24/X$$
$$X = 95.169486$$

The life cycle costs of downtime are:

American: 11,951 * 35.60/100/8 = $531.82
European: 9,994 * X/100/8 = $1,188.90

The total life cycle O&M costs are:

American: 16,290 + 531.82 = $16,821.82
European: 10,796.86 + 1,188.90 = $11,985.76

Appendix Q: Life Cycle O&M Cost Calculation for B/F263 (1 1/2 ton Stake & Platform Truck)

Life Expectancy: 9 years; 84,000 miles.

Warranty Period: 1 year.

Delivered Cost:
American: $28,012
European: $12,321

VIMS-Generated O&M Cost

RC	YEAR/ WEIGHT	AMERICAN O&M COST/MI	AMERICAN WEIGHTED COST/MI	EUROPEAN O&M COST/MI	EUROPEAN WEIGHTED COST/MI
U	1.0	.18	.18	.08	.08
T	3.5	.24	.84	.16	.56
R	2.5	.26	.65	Unknown	Unknown
N-Q	1.0	.31	.31	Unknown	Unknown
K-M	1.0	.49	.49	Unknown	Unknown
			2.47		X

The relationship is:

$$1.02/2.47 = .64/X$$
$$X = 1.5498039$$

The VIMS-generated life cycle O&M costs are:

American: 2.47/9 * 84,000 = $23,053.33
European: X/9 * 84,000 = $14,464.84

Downtime Cost

RC	YEAR/ WEIGHT	AMERICAN VOC%	AMERICAN WEIGHTED VOC%	EUROPEAN VOC%	EUROPEAN WEIGHTED VOC%
U	1.0	2.30	2.30	6.66	6.66
T	3.5	10.63	37.205	4.61	16.135
R	2.5	18.51	46.275	Unknown	Unknown
N-Q	1.0	8.00	8.00	"	"
K-M	1.0	13.04	13.04	"	"
			106.92		X

The relationship is:

$$39.505/106.92 = 22.795/X$$
$$X = 61.694504$$

The life cycle costs of downtime are:

American: 28,012 * 106.92/100/9 = $3,327.83
European: 12,321 * X/100/9 = $844.60

The total life cycle O&M costs are:

American: 20,748 + 3,327.83 = $24,075.83
European: 13,018.35 + 844.60 = $13,862.95

Appendix R: Life Cycle O&M Cost Calculation for B/F324 (5 ton Dump Truck, 4X2)

In this case there was not a complete set of life cycle data for European vehicles, American vehicles in Europe, or American vehicles throughout the Air Force. The 5 ton dump truck is a relatively new addition to the Air Force fleet. The 10 ton dump truck (B332), however, is a similar vehicle type that does have a complete life cycle record (not in Europe but in the Air Force worldwide). Therefore, American B332s worldwide (AF/AMER-332) were used as the basis for B/F324 LCC projections.

Life Expectancy: 10 years; 84,000 miles.

Warranty Period: 1 year.

Delivered Cost;
American: $37,942
European: $35,621

VIMS-Generated O&M Cost

RC	YEAR/ WEIGHT	AF/AMER-332 O&M COST/MI	AF/AMER-332 WEIGHTED COST/MI	AMERICAN O&M COST/MI	AMERICAN WEIGHTED COST/MI	EUROPEAN O&M COST/MI	EUROPEAN WEIGHTED COST/MI
U	1	.45	.45	Unknown	Unknown	.52	.52
T	4	.42	1.68	.64	2.56	.43	1.72
R	3	.74	2.22	1.38	4.14	"	"
N-Q	1	.96	.96	.16	.16	"	"
K-M	1	.07	.07	Unknown	Unknown	"	"
			5.38		X		Y

The relationships are:

$$4.86/5.38 = 6.86/X$$
$$X = 7.5939918$$

$$2.13/5.38 = 2.24/Y$$
$$Y = 5.6578404$$

The VIMS-generated O&M costs are:

American: 84,000 * X/10 = $63,789.53
European: 84,000 * Y/10 = $47,525.86

Downtime Costs

RC	YEAR/ WEIGHT	AF/AMERICAN VOC%	AF/AMERICAN WEIGHTED VOC%	AMERICAN VOC%	AMERICAN WEIGHTED VOC%	EUROPEAN VOC%	EUROPEAN WEIGHTED VOC%
U	1	8.00	8.00	Unknown	Unknown	3.11	3.11
T	4	11.41	45.64	11.36	45.44	4.79	19.16
R	3	16.12	48.36	17.96	53.88	Unknown	Unknown
N-Q	1	14.99	14.99	8.73	8.73	"	"
K-M	1	16.61	16.61	Unknown	Unknown	"	"
			133.60		X		X

The relationships are:

108.99/133.60 = 108.05/X
X = 132.44775

53.64/133.60 = 22.27/Y
Y = 55.467412

The life cycle downtime costs are:

American: 37,942 * X/100/10 =$5,025.33
European: 35,621 * Y/100/10 = $1,975.80

The total life cycle O&M costs are:

American: 63,789.53 + 5,025.33 = $68,814.86
European: 47,525.86 + 1,975.80 = $49,501.66

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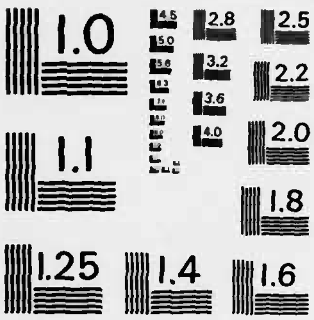

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Appendix S: Life Cycle O&M Cost Calculation for B/F332 (5 ton Dump Truck, 4X4)

The projections in these calculations are based on American vehicles Air Force wide (AF/AMERICAN) data due to insufficient life cycle data for both European and American vehicles in Europe.

Life Expectancy: 10 years; 84,000 miles.

Warranty Period: 1 year.

Delivered Cost:
American: $50,307
European: $40,035

VIMS-Generated O&M Cost

		AF/AMERICAN		AMERICAN		EUROPEAN	
	YEAR/	O&M	WEIGHTED	O&M	WEIGHTED	O&M	WEIGHTED
RC	WEIGHT	COST/MI	COST/MI	COST/MI	COST/MI	COST/MI	COST/MI
U	1	.45	.45	Unknown	Unknown	1.21	1.21
T	4	.42	1.68	.40	1.60	.35	1.40
R	3	.74	2.22	1.26	3.78	Unknown	Unknown
N-Q	1	.96	.96	Unknown	Unknown	"	"
K-M	1	.07	.07	"	"	"	"
			5.38		X		Y

The relationships are:

$$3.90/5.38 = 5.38/X$$
$$X = 7.421641$$

$$2.13/5.38 = 2.61/Y$$
$$Y = 6.5923944$$

The VIMS-generated life cycle costs are:

American: X/10 * 84,000 = $62,341.79
European: Y/10 * 84,000 = $55,376.11

Downtime Cost

RC	YEAR/ WEIGHT	AF/AMERICAN VOC%	AF/AMERICAN WEIGHTED VOC%	AMERICAN VOC%	AMERICAN WEIGHTED VOC%	EUROPEAN VOC%	EUROPEAN WEIGHTED VOC%
U	1	8.00	8.00	Unknown	Unknown	0.00	0.00
T	4	11.41	45.64	11.29	45.16	5.41	21.64
R	3	16.12	64.48	13.81	55.24	Unknown	Unknown
N-Q	1	14.99	14.99	Unknown	Unknown	"	"
K-M	1	16.61	16.61	"	"	"	"
			149.72		X		Y

The relationships are;

$$110.12/149.72 = 100.40/X$$
$$X = 136.50461$$

$$53.64/149.72 = 21.64/Y$$
$$Y = 60.401581$$

The life cycle costs of downtime are:

American: 50,307 * X/100/10 = $6,867.14
European: 40,035 * Y/100/10 = $2,418.18

The total life cycle O&M costs are:

American: 62,341.79 + 6,867.14 = $69,208.92
European: 55,376.11 + 2,418.18 = $57,794.29

Appendix T: Life Cycle O&M Cost Calculation for B/F353 (5 ton Truck Tractor)

Life Expectancy 10 years; 150,000 miles.

Warranty Period: 1 year.

Delivered Cost:
American: $40,869
European: $29,734

VIMS-Generated O&M Cost

RC	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1	.24	.24	.24	.24
T	4	.25	1.00	.21	.84
R	3	.36	1.08	Unknown	Unknown
N-Q	1	.22	.22	"	"
K-M	1	.81	.81	"	"
			3.10		x

The relationship is:

$$1.24/3.10 = 1.08/X$$
$$X = 2.7$$

The life cycle VIMS-generated O&M costs are:

American: 3.10101 * 150,000 = $46,500
European: X/10 * 150,000 = $40,500

Downtime Costs

RC	YEAR/ WEIGHT	AMERICAN VOC%	AMERICAN WEIGHTED VOC%	EUROPEAN VOC%	EUROPEAN WEIGHTED VOC%
U	1	9.80	9.80	15.18	15.18
T	4	8.33	33.32	5.57	22.28
R	3	14.89	44.67	Unknown	Unknown
N-Q	1	44.62	44.62	"	"
K-M	1	17.18	7.18	"	"
			149.59		X

The relationship is:

$$43.12/149.59 = 37.46/X$$
$$X = 129.95458$$

The downtime costs are:

$$\text{American: } 40{,}869 * 149.59/100/10 = \$6{,}113.59$$
$$\text{European: } 29{,}734 * X/100/10 = \$3{,}864.07$$

The total life cycle O&M costs are:

$$\text{American: } 49{,}227.27 + 6{,}085.39 = \$55{,}312.66$$
$$\text{European: } 42{,}875.37 + 3{,}846.25 = \$46{,}751.62$$

Appendix U: Life Cycle Cost Calculation for B/F361&363 (7 1/2 ton & 10 ton Truck Tractor)

Calculations in this instance were based on projections from American vehicles Air Force wide (AF/AMERICAN) due to lack of complete life cycle data sets for either European or American vehicles in Europe.

Both vehicle types (7 1/2 and 10 ton truck tractors) were averaged together using 1983 assignment figures for weights. These two vehicle types are unusual in that they are treated as separate management codes (B/F 361 and B/F 363) for maintenance purposes, yet treated as the same vehicle for authorization and acquisition purposes. It seemed appropriate, therefore, to arrive at average O&M/VOC costs using 1983 assignment figures for weights and to treat them, henceforth, as the same vehicle. The year 1983 was used because it is the most recent year, was convenient (from the same 7110 report), and was releveant to the 1983 O&M/VOC data. The underlying assumption, of course, being that 1983 was representative of an on-going balance between the two sizes of truck tractors.

Life Expectancy: 12 years; 150,000 miles.

Warranty Period: 1 year.

Delivered Cost:
American: $55,349.00
European: $42,155.00

VIMS-Generated O&M Cost

		AF/AMERICAN		AMERICAN		EUROPEAN	
R/C	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1	.275	.275	Unknown	Unknown	.380	.380
T	5	.357	1.785	.418	2.090	.297	1.485
R	4	.359	1.436	.939	3.756	Unknown	Unknown
N-Q	1	.515	.515	Unknown	Unknown	*	*
K-M	1	.992	.992	*	*	*	*
			5.003		X		Y

The relationships are:

$$3.221/5.003 = 5.846/X$$
$$X = 9.0802664$$

$$2.06/5.003 = 1.865/Y$$
$$Y = 4.529415$$

The VIMS-generated life cycle O&M costs are:

American: 150,000 * X/12 = $113,503.33
European: 150,000 * Y/12 = $56,617.69

Downtime Costs

		AF/AMERICAN		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	VOC%	WEIGHTED VOC%	VOC%	WEIGHTED VOC%	VOC%	WEIGHTED VOC%
U	1	2.251	2.251	Unknown	Unknown	16.500	16.500
T	5	10.954	54.770	14.011	70.055	9.556	47.780
R	4	11.600	46.400	20.018	80.072	Unknown	Unknown
N-Q	1	12.075	12.075	Unknown	Unknown	*	*
K-M	1	10.208	12.208	*	*	*	*
			125.704		X		Y

The relationships are:

$$101.17/125.704 = 150.127/X$$
$$X = 186.53321$$

$$57.021/127.704 = 64.28/Y$$
$$Y = 143.96123$$

The life cycle costs of downtime are:

American: 55,349 * X/100/12 = $8,603.69
European: 42,155 * Y/100/12 = $5,057.24

The total life cycle O&M costs are:

American: 113,503.33 + 8,603.69 = $122,107.02

European: 56,617.69 + 5,057.24 = $61,674.93

Appendix V: Life Cycle Cost Calculation for E/F816 (4000 lb. Forklift)

Complete life cycle data are not available for either E816 (American in Europe or Air Force worldwide) or F816 (European). The projections for the American and European vehicles in this management code are based on the life cycle data from E831 (2000 - 5999 lb. gasoline forklift) throughout the Air Force. E831 is the most similar vehicle about which there is available full life cycle data.

Life Expectancy: 8 years; 9,000 hours.

Warranty Period: 1 year.

Delivered Cost:
American: $17,680
European: $23,385

VIMS-Generated O&M Costs

		AF/AMER-831		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	O&M COST/MI	WEIGHTE[D] COST/M[I]	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1	.94	.94	Unknown	Unknown	1.47	1.47
T	3	2.69	8.07	2.03	6.09	3.18	9.54
R	2	1.78	3.56	Unknown	Unknown	Unknown	Unknown
N-Q	1	3.96	3.96	"	"	"	"
K-M	1	6.26	6.26	"	"	"	"
			22.79		X		Y

The relationships are:

$$8.07/22.79 = 6.09/X$$
$$X = 17.198401$$

$$9.01/22.79 = 11.01/Y$$
$$Y = 27.848824$$

The life cycle VIMS-generated O&M costs are:

American: 9,000 * X/8 = $19,348.20
European: 9,000 * Y/8 = $31,329.93

Downtime Costs

		AF/AMERICAN		AMERICAN		EUROPEAN	
	YEAR/		WEIGHTED		WEIGHTED		WEIGHTED
RC	WEIGHT	VOC%	VOC%	VOC%	VOC%	VOC%	VOC%
U	1	2.54	2.54	Unknown	Unknown	5.67	5.67
T	3	6.37	19.11	1.66	4.98	10.52	31.56
R	2	8.15	16.30	Unknown	Unknown	Unknown	Unknown
N-Q	1	8.82	8.82	"	"	"	"
K-M	1	13.20	13.20	"	"	"	"
			59.97		X		Y

The relationships are;

19.11/59.97 = 4.98/X
X = 15.627975

21.64/59.97 = 37.23/Y
Y = 13.434337

The life cycle downtime costs are:

American: 17,680 * X/100/8 = $345.38
European: 23,385 * Y/100/8 = $392.70

The life cycle total O&M costs are:

American: 19,348.20 + 345.38 = $19,693.58
European: 31,329.93 + 392.70 = $31,722.63

Appendix W: Life Cycle O&M Cost Calculation for E/F822 (6,000 lb. Forklift)

In the absence of complete life cycle data for E822 (European and worldwide) and F822, E831 (gasoline forklift, 2000 - 5999 lb.), worldwide, served as the basis for projections. E831 is a similar vehicle type and has complete life cycle data.

Life Expectancy: 10 years; 9,000 hours.

Warranty Period: 1 year.

Delivered Cost:
American: $33,274
European: $31,715

VIMS-Generated O&M Costs

		AF/AMER-831		AMERICAN		EUROPEAN	
RC	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1	.94	.94	.17	.17	.56	.56
T	4	2.69	10.76	.52	1.08	4.42	17.68
R	3	1.78	5.34	3.79	11.37	Unknown	Unknown
N-Q	1	3.96	3.96	Unknown	Unknown	"	"
K-M	!	6.26	6.26	"	"	"	"
			27.26		X		Y

The relationships are:

$$17.04/27.26 = 12.62/X$$
$$X = 20.189038$$

$$16.1/27.26 = 18.24/Y$$
$$Y = 30.883379$$

The VIMS-generated life cycle O&M costs are:

American: 9,000 * X/10 = $18,170.13
European: 9,000 * Y/10 = $27,795.04

Downtime Costs

		AF/AMER-831		AMERICAN		EUROPEAN	
	YEAR/		WEIGHTED		WEIGHTED		WEIGHTED
RC	WEIGHT	O&M%	O&M%	O&M%	O&M%	O&M%	O&M%
U	1	2.54	2.54	.41	.41	2.23	2.23
T	4	6.37	25.48	8.90	35.60	13.71	54.84
R	3	8.15	24.45	23.85	71.55	Unknown	Unknown
N-Q	1	8.82	8.82	Unknown	Unknown	"	"
K-M	1	13.20	13.20	"	"	"	"
			74.49		X		Y

The relationships are:

$$52.47/74.49 = 107.56/X$$
$$X = 152.70$$

$$49.93/74.49 = 57.07/Y$$
$$Y = 85.142085$$

The life cycle costs of downtime are:

American: 33,274 * X/100/10 = $5,080.94
European: 31,715 * Y/100/10 = $2,700.28

The total life cycle O&M costs are:

American: 18,170.13 + 5,080.94 = $23,251.07
European: 27,795.04 + 2,700.28 = 30,495.32

Appendix X: Life Cycle O&M Cost Calculation for E/F824 (15,000 lb. Forklift)

There is not a full set of life cycle data for either European or American (including worldwide) vehicles of this type. E831 (gasoline forklift, 2000 - 5999 lb.), worldwide, is a similar vehicle type that has a complete set of life cycle data. E831 is the basis for E824 in Europe and F824 projections.

Life Expectancy: 10 years; 12,000 hours.

Warranty Period: 1 year.

Delivered Cost;
American: $43,233
European: $45,854

VIMS-Generated O&M Costs

		AR/AMER-831		AMERICAN		EUROPEAN	
RM	YEAR/ WEIGHT	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI	O&M COST/MI	WEIGHTED COST/MI
U	1	.94	.94	Unknown	Unknown	Unknown	Unknown
T	4	2.69	10.76	2.37	9.48	3.56	14.24
R	3	1.78	5.34	Unknown	Unknown	Unknown	Unknown
N-Q	1	3.96	3.96	"	"	"	"
K-M	1	6.26	6.26	"	"	"	"
			29.26		X		Y

The relationships are;

$$10.76/27.26 = 9.48/X = 14.24/Y$$
$$X = 24.017175$$
$$Y = 36.076431$$

The life cycle VIMS-generated O&M costs are:

American: 12,000 * X/10 = $28,820.61
European: 12,000 * Y/10 = $43,291.72

Downtime Costs

RC	YEAR/ WEIGHT	AF/AMER-831 O&M%	AF/AMER-831 WEIGHTED O&M%	AMERICAN O&M%	AMERICAN WEIGHTED O&M%	EUROPEAN O&M%	EUROPEAN WEIGHTED O&M%
U	1	2.54	2.54	Unknown	Unknown	Unknown	Unknown
T	4	6.37	25.48	12.03	48.12	7.39	29.56
R	3	8.15	24.45	Unknown	Unknown	Unknown	Unknown
N-Q	1	8.82	8.82	"	"	"	"
K-M	1	13.20	13.20	"	"	"	"
			74.49		X		Y

The relationships are:

$$25.48/74.49 = 48.12/X = 29.56/Y$$
$$X = 140.67735$$
$$Y = 86.417755$$

The life cycle downtime costs are:

American: 43,233 * X/100/10 = $6,081.90
European: 45,854 * Y/100/10 = $3,962.60

The life cycle total O&M costs are:

American: 28,820.61 + 6,081.90 = $34,902.51
European: 43,291.72 + 3,962.60 = $47,254.32

Appendix Y: Fleet Annual Life Cycle Costs
(1983 Dollars)

FALCC = ((DC + O&M - SV) / LE) * AUTH

Where,

DC = Delivered Cost
O&M = Life Cycle Operation and Maintenance Cost
SV = Salvage Values
LE = Life Expectancy in Years
AUTH = Authorizations in F.R.G., U.K., and Italy
FALCC = Fleet's Annual Life Cycle Cost

121
AMER: ((36171.00 + 53671.10 - 269.84)/ 14) * 399 = 2552809.40
EURO; ((28533.00 + 36504.70 - 305.41)/ 14) * 399 = 1844870.30

130
AMER: ((43701.00 + 74971.01 - 377.86)/ 14) * 220 = 1858908.10
EURO: ((61880.00 + 58925.91 - 2678.54)/14) * 220 = 1856287.20

139
AMER: ((173047.00 + 126221.33 - 6066.26) / 12) * 1 = 24433.51
EURO: ((155405.00 + 107012.61 - 13287.13)/ 12) * 1 = 20760.87

168
AMER: ((12169.00 + 12156.81 - 249.82) / 8) * 377 = 1134581.50
EURO: ((7383.00 + 9874.29 - 763.71) / 8) * 377 = 777259.96

176
AMER: ((20234.00 + 23228.50 - 135.05)/ 7) * 1387 = 8585024.72
EURO: ((10447.00 + 19465.79 - 335.80)/ 7) * 1387 = 5860469.33

185
AMER: ((13397.00 + 13162.01 - 442.25) / 8) * 684 = 2232986.40
EURO: ((7346.00 + 10679.88 -1202.20) / 8) * 684 = 1438424.60

192
AMER: ((14385.00 + 17346.27 - 139.32) / 8) * 57 = 225093.00
EURO: ((12663.00 + 15171.17 - 1035.43) / 8) * 57 = 190940.88

204
AMER: ((10033.00 + 12990.49 - 436.67)/ 7) * 2841 = 9167026.29
EURO: ((7967.00 + 10535.67 - 942.18) / 7) * 2841 = 7127046.34

217
AMER: ((13741.00 + 18373.80 - 642.33) / 8) * 793 = 3119709.58
EURO: ((7564.00 + 11543.79 - 329.37) / 8) * 793 = 1861408.90

<u>261</u>
AMER: ((11951.00 + 16821.82 - 507.76) / 8) * 145 = 512304.21
EURO: ((9994.00 + 11985.76 - 525.50) / 8) * 145 = 388858.46

<u>263</u>
AMER: ((28012.00 + 24075.83 - 1190.15)/ 9) * 595 = 3364902.20
EURO: ((12321.00 + 13862.95 - 647.86) / 9) * 595 = 1688219.30

<u>324</u>
AMER: ((37942.00 + 68814.86 - 545.01)/ 10) * 194 = 2060509.90
EURO: ((35621.00 + 49501.66 - 3850.33)/10) * 194 = 1576682.20

<u>332</u>
AMER: ((50307.00 + 69208.92 - 432.37) / 10) * 42 = 500150.92
EURO: ((40035.00 + 57794.29 - 7166.43) / 10) * 42 = 380784.01

<u>353</u>
AMER: ((40869.00 + 55312.66 - 1352.77) / 10) * 57 = 540524.67
EURO: ((29734.00 + 46751.62 - 1925.33) / 10) * 57 = 424993.65

<u>361/363</u>
AMER: ((55349.00 + 122107.02 - 3039.58)/12)* 474 = 6889449.40
EURO: ((42155.00 + 61674.93 - 3311.56)/12) * 474 = 3970475.62

<u>816</u>
AMER: ((17680.00 + 19693.58 - 1396.41)/ 8) * 279 = 1254703.75
EURO: ((23385.00 + 31722.63 - 3299.26)/ 8) * 279 = 1806816.90

<u>822</u>
AMER: ((33274.00 + 23251.07 - 3092.95)/10) * 747 = 3991379.40
EURO: ((31715.00 + 30495.32 - 6389.65)/10) * 747 = 4169804.00

<u>824</u>
AMER: ((43233.00 + 34902.51 - 1408.70) / 10) * 23 = 176471.66
EURO: ((45854.00 + 47254.32 - 11286.54)/ 10) * 23 = 188190.09

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The purpose of this research was to determine if the European Vehicle Buy Program is economical. Approximately 6,000 vehicles have been purchased through the program, with 3,000 more to be bought in the near future.

A life cycle cost (LCC) model was used to determine costs. Historical costs were input into the LCC model. Extrapolation techniques were developed to project costs when historical data were not available.

This analysis supported previous studies which concluded that the European Vehicle Buy Program was economical. It concluded that the program's total cost will be $12.6 million (26%) per year less than the alternative, buying and operating American vehicles. The program can be improved to save $13.4 million (28%) per year by buying certain vehicle types in the United States and sending them to Europe. The additional benefit of enhanced interoperability with NATO allies also lends supportto continuing the European Vehicle Buy Program.

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